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A STUDY OF PROBABLE ERROR METHODS IN FIELD EXPERIMENTS*

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The probable error concept has found wide usage in the interpretation of the significance of experimental results as obtained in field studies. Some means of statistically determining the significance of the data obtained appears desirable in order to compare two or more results. The probable error is the common measure of reliability now being used.

One of the difficulties of field experiments is that numerous comparisons must be made. In plant breeding or varietal trials it is impossible, as a rule, to have more than a few replicates of each variety or strain. The question arises which method of calculating and applying the probable error is most advisable and mathematically reliable for this type of data.

Several specific subjects have received some consideration, although no very extensive mathematical comparisons of various methods have been made. Some investigators have used probable errors for each variety calculated directly from three or four determinations. Others have obtained a generalized probable error, i.e., an average expression of the relative variability of all varieties and have considered this more reliable than separate probable errors calculated independently for each variety. Many questions regarding replication have been discussed. Some believe in a random distribution of the plots of each variety so that all varieties are grown in the tribution of each plot of each variety so that all varieties are grown in the same relative order and as far as possible in representative sections of the total area used in the trial. In the use of a generalized probable error it is important to know whether the variability in yield as measured by the probable error is of the same relative magnitude for varieties or strains of different yielding ability.

The studies presented here are a definite attempt to answer these particular questions by the use of statistical constants obtained from actual field data.

EXPERIMENTAL RESULTS

In order to compare the reliability of separate probable errors calculated directly from each variety with a generalized probable error, it seemed desirable to use data from a single variety. It is recognized that some varieties respond more readily to soil heterogeneity differences than others but in many plant breeding experiments the strains are of a similar origin.

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Data, published by Garber et al. (*2*) in which yields of small plots of the same variety of wheat were given, were used in studies of the relative reliability of a generalized probable error and of separate probable errors calculated from each variety. The plots as grown were arranged in a rectangle, 45 plots long by 4 plots wide, each plot being 68 x 21 feet. In the "uniformly replicated" series plots 1, 62, 123, and 184; 2, 63, 124, and 185, etc., were used to represent separate determinations for each of the 45 hypothetical "varieties". In the "random replication" the position of each of the 45 "varieties" in each of the four rows was obtained by a random or chance distribution. This was accomplished by shuffling 45 cards and drawing for position.

Separate probable errors were calculated for each "variety" of four plots by the use of the formula: P. E. of a single determination $= \pm .6745 \sqrt{\frac{\Sigma d^2}{N-1}}$ where d = the deviation of each plot from the "variety" mean and N = the number of plots averaged. The generalized probable error, called "the deviation from the mean method", as suggested by Hayes (*3*) and corrected by "Student" (*9*) was calculated from this formula: P. E. single determination $= \pm .6745 \sqrt{\frac{\Sigma d^2 (n)}{N (n-1)}}$ where N = the number of deviations considered, and n = the number of plots of each "variety" and d represented the deviation in bushels of each plot of each "variety" from its "variety" mean. A generalized probable error suggested by "Student" (*8*) was also used. This formula was used: P. E. single determination $= \pm .6745 \sqrt{\frac{M\ N\ (\sigma^2_T - \sigma^2_R - \sigma^2_G)}{(M-1)\ (N-1)}}$ in which σ^2_T is that obtained by considering the deviations of each plot from the mean of all plots in the test, σ^2_R is the squared standard deviation or variance calculated from the means of the varieties or strains, σ^2_G is the variance calculated from the mean yields of all varieties in each of the separate replication series, which was four in this problem, M = the number of varieties and N = the number of replicated plots of each variety. In calculating σ, n–1 was used in the denominator for less than 50 variates.

The generalized probable error calculated by the "deviation from the mean" method was used in two ways. First, it was used directly in bushels and second, it was expressed in percentage of the general mean and then this percentage multiplied by the mean yield of each "variety" to obtain the probable error in bushels for that "variety".

The mean yield of each "variety" was compared with the general mean of all "varieties" in the light of their probable errors and it was determined how many times the difference exceeded the probable error of the difference. The number of times that deviations between 0 and 1, between 1 and 2, etc., times the probable error of the difference would be expected on the basis of random sampling was calculated and used as a standard of comparison for the different types of probable errors. These data are given in Table 1.

TABLE 1.—*The extent of deviation between the means of 45 "varieties" of 4 plots each arranged in a uniform or random replication, and the mean of all plots, in the light of the probable error of the difference. (Data of Garber, McIlvaine and Hoover. Same variety of wheat grown throughout the field).*

Method of calculating probable error	Classes for difference between "varieties" and general mean divided by P.E. of difference.							
	0–1.0	1.1–2.0	2.1–3.0	3.1–4.0	4.1–5.0	5.1–6.0	6.1–7.0	7.1–8.0
Separate P.E. for each "variety" when uniformly replicated	25	15	4			1		
Same as above except plots distributed at random within each replicate	26	14	2		2			(19 x P.E.) 1
Generalized P.E. by dev. from mean method for 4 plots uniformly replicated. P.E. in bu. used directly	29	11	5					
Same as above except plots distributed at random within each replicate	31	8	3	2	1			
Generalized P.E. by dev. from mean method for 4 plots uniformly replicated. P.E. expressed in % before using	30	10	4	1				
Same as above except plots distributed at random within each replicate	32	7	4	1			1	
Generalized P.E. by method of "Student" for 4 plots uniformly replicated. P.E. in bu. used directly	31	8	3	2	1			
Mathematical expectation	22.5	14.5	6.0	1.6	.3	.03	.002	

It seems, from these data, that it made little difference, except for one wide deviation in the random distribution, whether the plots were uniformly replicated or distributed at random within each replicate. As uniform replication is easier, random distribution does not seem desirable, in this case.

In comparing the separate probable errors calculated for each "variety" with the generalized probable error for the uniformly replicated test, it is evident that in using separate probable errors for such a small number of plots a few very wide deviations are obtained when they are not expected. Conclusions based on these wide deviations from expectation would be erroneous. The deviations from expectation were approximately the same whether the probable error was used in bushels directly or expressed in percentage and then multiplied by each "variety". This should be expected from data such as those used in this study. "Student's" generalized probable error was slightly lower than that obtained by the deviation from the mean method and, therefore, gave wider deviations from expectation.

In Table 2 the same type of calculations were made on 500 plots of the same variety of wheat harvested in small plots and reported by Mercer and Hall (5).

These 500 plots as grown were arranged in the form of a rectangle, and 125 "varieties" of four plots each were arranged and studied as a uniform replication.

TABLE 2.—*The extent of deviation between the means of 125 "varieties" of 4 plots each, arranged in a uniform replication, and the mean of all plots, in the light of the probable error of the difference. (Mercer and Hall data, same variety of wheat grown throughout the field).*

Method of calculating probable error	Classes for difference between "varieties" and general mean divided by P.E. of difference.							
	0–1.0	1.1–2.0	2.1–3.0	3.1–4.0	4.1–5.0	5.1–6.0	6.1–7.0	7.1–8.0
Separate probable error for each "variety"	59	36	14	10	3	1		2
Generalized probable error by dev. from mean method. P.E. in bu. used directly	54	53	13	5				
Same as above except P.E. expressed in % before using	57	48	18	2				
Generalized probable error by method of "Student". P.E. in bu. used directly	45	42	27	9	2			
Same as above except P.E. expressed in % before using	44	42	27	12				
Mathematical expectation	62.5	40.3	16.8	4.5	.8	.09	.006	

In this table, as in Table 1, when separate probable errors were calculated for each "variety," a few very wide deviations were found when such should not be expected. Such large deviations were not encountered when generalized probable errors were used. Again, in this table, it made little difference whether the generalized probable error was used directly in bushels or expressed in percentage and calculated for each "variety" before using. In this comparison "Student's" formula gave a probable error somewhat smaller than that given by the "deviation from the mean" method. When both were compared with mathematical expectation, the method of "Student" resulted in wider deviations than the "deviation from the mean" method and did not so closely approximate what would be expected on the basis of random sampling as did the latter method. It will be remembered that the so-called 125 "varieties" considered in this calculation were actually all the same variety of wheat and were grown on a total area of one acre.

A question of considerable interest in agronomic experiments is whether the probable error is the same for varieties of different yields and whether the probable error used in bushels directly or expressed in percentage before using is the more reliable. In attempting to answer this problem the yield data on rod rows of spring wheat grown at University Farm, St. Paul, Minn., and at the sub-stations Waseca, Crookston, and Morris, Minn., were used from which to calculate the probable errors. The range in yield for each class of varieties was divided evenly into three groups; as, low, medium, and high yielding groups. The generalized probable error for a single determination was calculated by the "deviation from the mean" method separately for the low, medium, and high yielding varieties. This probable error was expressed in bushels as well as in percentage of the general mean. The data are given in tables 3 and 4.

Table 3.—*Probable errors in bushels for a single determination for varieties of wheat classified into three groups on the basis of their yielding ability.*

Station, Variety Group and Method of Trial	Range of Yield of Group			No. of Dev.			P.E. in Bushels			All
	Low	Med.	High	Low	Med.	High	Low	Med.	High	var.
Waseca, vulgare, 3 row	9.4—13.8	13.9—18.3	18.4—22.8	21	27	24	2.07	2.15	1.80	2.02
Crookston, vulgare, single row	8.6—14.9	15.0—21.2	21.3—27.9	18	75	54	1.23	2.17	2.95	2.40
Crookston, durum, single row	18.8—23.2	23.3—27.7	27.8—32.2	27	51	33	2.12	2.60	4.50	3.20
Morris, Vulgare, single row	21.0—26.4	26.5—31.9	32.0—37.9	39	60	36	1.66	1.92	1.80	1.82
U. Farm, vulgare, 3 row	14.5—21.2	21.3—28.0	28.1—34.7	28	96	52	2.30	2.69	2.54	2.59
U. Farm, vulgare, single row	13.2—21.3	21.4—29.4	29.5—37.6	48	192	84	2.52	2.73	2.91	2.75
U. Farm, durum, 3 row	27.2—31.6	31.7—36.0	36.1—40.5	52	32	32	2.59	3.66	2.99	3.02
U. Farm, durum, single row	25.5—30.6	30.7—35.7	35.8—40.9	88	100	68	3.10	2.90	2.69	2.92
Average							2.20	2.60	2.77	2.59
							7+ 1-		3+ 5-	10+ 6-

Table 4.—*Probable error in percentage for a single determination for varieties and groups listed in Table 3.*

Station, Variety Group and Method of Trial	Probable Error in Percentage			
	Low	Med.	High	All varieties
Waseca, vulgare, 3 row	16.96	12.87	8.70	12.07
Crookston, vulgare, single row	10.56	12.36	12.60	12.64
Crookston, durum, single row	10.05	10.04	14.71	12.25
Morris, vulgare, single row	6.89	6.55	5.23	6.24
U. Farm, vulgare, 3 row	13.07	10.85	8.27	10.19
U. Farm, vulgare, single row	13.86	11.03	8.78	10.59
U. Farm, durum, 3 row	8.80	10.84	7.98	9.20
U. Farm, durum, single row	11.01	8.79	7.17	8.98
Average	11.40	10.42	9.18	10.27

It will be noted that on the average the probable error in bushels increased as the yields of the varieties increased. The probable error in percentage decreased as the yields of the varities increased. In most varietal trials the yields of the higher yielding varieties are of most interest. A probable error in bushels calculated for each variety by multiplying the generalized probable error in percentage by the mean yield of each variety is more conservative than the same generalized probable error in bushels used for all varieties.

In a test of 79 varieties and crosses of corn in 1927 at University Farm, St. Paul, Minn., each variety or cross was grown in five systematically distributed plots. Due to the fact that not all of this corn could be grown on one field it was found necessary to grow three plots of each variety on one field and the other two plots on another field separated from the first by at least half a mile.

The probable error of a single determination calculated from all replicates by the "deviation from the mean" method was found to be 7.14 bushels or 12.59%. In using the formula of "Student," $\sigma^2_T = 139.77$, $\sigma^2_R = 49.35$ and $\sigma^2_G = 25.12$. Variance due to varieties and replication groups was relatively large in this case. The mean yield of the three replicates in one field was 64.04, 58.75, and 50.87 bushels, respectively, and 55.61 and 54.01 bushels in the other field. This wide difference in the mean yield of the replicate series resulted in a fairly large σ^2_G. The probable error of a single determination, as calculated by the method of "Student," was 6.13 bushels or 10.81%. This is an appreciable reduction over the probable errors of 7.14 bushels or 12.59% obtained by the "deviation from the mean" method. "Student's" method is essentially a method whereby the average correlated variation among the varieties in the different replication series is eliminated from the average variance of all varieties in the experiment. In problems such as the above, in which the difference in yields between replication series is fairly large, "Student's" method can be expected to correct for this fact and give a lower probable error than the "deviation from the mean" method. The correction will be reliable only when all plots in each replication series are on soil of similar yielding ability. In such tests as rod row trials of small grains the plots will usually be grown on a comparatively small area and the variance due to replicates will be small, resulting in little reduction to the total variance by "Student's" method. In yield trials conducted on larger plots, where the test extends over a considerable area of ground, the variance due to replicates will often be of sufficient magnitude to make this correction of considerable significance.

For agronomic experiments in which a large number of varieties or strains are being tested and only 3 or 4 replications are used, a generalized probable error may be calculated by either the "deviation from the mean" method or by the method of "Student." Sometimes one and sometimes the other will prove to be more desirable. When a comparatively small number of varieties are to be replicated more times, as in making the final yield test and comparing a few of the most desirable varieties, more refined methods of planning the experiment and calculating the probable error may be resorted to. Richey's *(6, 7)* moving average method gives a generalized

probable error in the calculation of which there is an attempt to remove all correlated variation. He suggests further the correction of yields on the basis of the regression to a moving average. The calculations are rather laborious but under the conditions of most yield trials on small areas the probable error will be slightly smaller than by the method of "Student."

The extent of correlation between nearby plots or of systematic variability from one side of a field to another should help in a decision of which method to use. In most experiments with rod row trials conducted at University Farm, St. Paul, Minnesota, correlation is chiefly a factor in nearby plots. The determination of the extent of correlation and when advisable the use of this correlation coefficient in a comparison of varieties located in nearby plots may be worth while (see Hayes and Garber, 4, p. 65.) In most preliminary yield trials or small plot tests correlated variability may be disregarded, unless it is a very important factor.

Another method outlined by Fisher *(1)* and illustrated by "Student" *(9)* is an attempt to correct for soil heterogeneity in both directions across the experimental area and to overcome other features of soil heterogeneity by random distribution of the plots, with certain restrictions. It is called the "Latin Square" method. Few experimental tests of the reliability of the method have been made and for plant breeding trials in which a large number of strains are compared the calculations needed would appear almost prohibitive.

SUMMARY.

1. One of the difficulties of field experiments is that frequently a large number of varieties or strains must be compared and only a few replications for each variety can be grown.

2. The reliability of different probable error methods was studied in the light of mathematical expectation.

3. Data on yields of small plots all grown to the same variety of wheat were used in making a part of this study. The yields of the small plots were treated as if they represented data obtained from a study of different varieties grown in replicated plots.

4. Conclusions drawn from separate probable errors calculated for each "variety" of four plots would have been erroneous in a number of instances due to the wide deviation of the yields of these "varieties" from expectation.

5. Conclusions drawn from generalized probable errors did not suffer from this defect.

6. No advantage was found in the random arrangement of plots within each replicate over a uniform replication in the single case tested and when compared as in the problem.

7. The "deviation from the mean" method more closely approximated mathematical expectation than did "Student's" method in the two comparisons made. "Student's" method gave a slightly lower probable error.

8. "Student's" generalized probable error corrects for that type of variability which results in different average yields for the varieties in the different replication series. It would have an advantage over the "deviation from the mean" method when the mean yields of the different replication series are distinctly different and each replication series is grown on soil of fairly uniform yielding ability.

9. The generalized probable error in bushels increased and the generalized probable error in percentage decreased as the yield of the varieties increased.

10. A generalized probable error calculated as a percentage of the general mean may be used to calculate the probable error in bushels for each variety. This is a more conservative measure of the reliability of high yielding varieties than the same generalized probable error in bushels used for all varieties.

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LITERATURE CITED

1. Fisher, R.A. 1925. Statistical Methods for Research Workers. Oliver and Boyd, Edinburgh.

2. Garber, R.J.; McIlvaine, T.C., and Hoover, M.M. 1926. A Study of Soil Heterogeneity in Experiment plots. Jour. Agr. Res. *33:* 255-268.

3. Hayes, H.K. 1923. Controlling Experimental Error in Nursery Trials. Jour. Am. Soc. Agron. *15:* 177-192.

4. ——————and Garber, R.J. 1927. Breeding Crop Plants. McGraw-Hill Book Company.

5. Mercer, W.B. and Hall A.D. 1911. The Experimental Error of Field Trials. Jour. Agr. Sci. *4:* 107-132. (page 119).

6. Richey, F.D. 1924. Adjusting Yields to their Regression on a Moving Average as a Means of Correcting for Soil Heterogeneity. Jour. Agr. Res. *27:* 79-90.

7. —————— 1926. The Moving Average as a Basis for Measuring Correlated Variation in Agronomic Experiments. Jour. Agr. Res. *32:* 1161-1175.

8. "Student" 1923. On testing Varieties of Cereals. Biometrika *15:* 271-293.

9. ——————1926. Mathematics and Agronomy. Jour. Am. Soc. Agron. *18:* 703-719.

A RAPID METHOD FOR DETERMINING THE MOULD AND YEAST COUNT OF BUTTER.*

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Introduction.

Since the Prairie Provinces commenced exporting their surplus butter direct to Great Britain in 1923, the mould and yeast analysis of creamery butter has received increasing attention. One reason for this was the occurrence of mould upon occasional churnings among the earlier shipments, which tended to undermine the otherwise excellent reputation that this butter was establishing for itself in Great Britain. To assist the manufacturers in overcoming this costly defect, mould and yeast analyses were inaugurated by the Provincial and Federal Dairy Branches in the Prairie Provinces and Ontario. The information thus obtained has been of distinct value, not only for this purpose, but also as an indication of the sanitary conditions prevailing in the various creameries. Pasteurized cream butter is required to give a negative reaction to the Storch test for peroxidase, necessitating the heating of the cream to 75°C. or higher, which is considerably above the thermal death point of yeasts and moulds. If, then, butter made from cream so treated contains large numbers of moulds and yeasts, either the cream or the resulting butter has become recontaminated, implying laxity in regard to sanitary conditions at the particular creamery.

Although little work has been done so far to show a correlation between mould and yeast counts and score or keeping quality, yet the larger butter manufacturers, both in Canada and the United States, have taken steps to reduce mould and yeast counts to a minimum by installing laboratories of their own and analysing every churning made, both in their city plants and at their country branches. This, together with the interest shown in the Mould and Yeast Contest conducted by the *World's Butter Review* this summer, in which 137 Canadian creameries have entered, indicates that this phase of buttermaking is receiving increasing attention, with a view to avoiding loss from mould development, and to improving the sanitary quality of the product.

In the routine analyses referred to above, the technique employed in Canada is a Petri dish method, using acidified wort agar, and incubating for five days at room temperature. This method will be referred to in this paper as the Standard Plate Method. The outstanding disadvantages of this method are (1) the amount of glassware required, and (2) the delay in obtaining results. With a view to avoiding these drawbacks, the author, during the winter of 1925-26, undertook to develop a more rapid method which might be of value as a supplement to the Standard Plate Method.

Review of Previous Investigations.

Of those investigators who have studied the mould and yeast content of butter, Bouska and Brown *(1)*, Lund *(2)*, Brown, Smith and Ruehle *(3)*,

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Grimes *(4),* Hood and White *(5),* Parfitt *(6),* Macy *(7)* and others have all utilized the petri dish method. Redfield *(8)* in 1919, adapted the direct microscopic method of Breed *(9)* for counting bacteria in milk, to the determination of yeasts and oidia in cream and butter. Counts so obtained were compared with those furnished by the petri dish method. A study of the results reported leads one to conclude that *a direct microscopic technique cannot be relied upon to give a satisfactory indication of the mould and yeast content of butter,* because it is impossible to distinguish between viable and dead cells. As a result, butter containing less than 10 moulds or yeasts per c.c. by the petri dish method frequently gave counts approaching or passing the million mark by the microscopic method.

In 1920, North and Reddish *(10)* checked Redfield's technique, using high grade experimental butter. They concluded that in general this method can be used to show the relative numbers of yeasts and oidia in a sample of butter. While this may hold with the special samples these workers analysed, the results of Redfield on average routine samples are sufficient, in the author's opinion, to cause one to question seriously the accuracy of the method. North and Reddish also attempted the plating out of the curd-brine serum obtained from melted butter, in hopes of establishing a ratio between counts thus made and those obtained from plating the entire butter. Encountering great variability, they concluded that no ratio could be established.

Besides the inability to distinguish living from dead cells, the direct microscopic method possesses another serious disadvantage in being unable to state a count as less than 5,000 per c.c. when 100 fields are counted and no organism encountered. These two disadvantages appear sufficient, then, to rule out this method for determining the mould and yeast content of butter, leaving us with no rapid method with which to supplement the petri dish method. The results reported under Investigational, Part I, deal with an attempt to develop such a method, which will be termed the Microplate Method.

INVESTIGATIONAL. PART I.

Development of Method

As was mentioned in the review of previous investigations, the only rapid method published so far possesses the drawbacks of (1) inability to differentiate between living and dead cells, and (2) a lower limit of counting of 5,000 per c.c. To avoid these shortcomings, the author after mature consideration turned to the technique devised by Frost *(11).* This method, known as the Little Plate Method of Milk Analysis, has been shown by Simmonds *(12),* Hatfield and Park *(13)* and others to compare favorably with the official plate count method in routine milk analysis. With this method, the colonies developing on a small agar "plate" are stained and counted under the low power objective of a microscope. Perceiving that this avoids both main objections to the Breed method, the author considered it worth while attempting to adapt this technique to the mould and yeast analysis of butter. The most important factors considered in attempting this adaptation will be discussed at some length, concluding with a detailed description of the technique as finally adopted.

Media

As Lund's *(2)* wort agar is the medium employed in the Standard Plate Method of mould and yeast analysis in Canada, this was adopted with the following slight modifications:—

1. Autoclaving the wort and filtering through cotton, repeating until no further appreciable amount of heat coagulable constituents are thrown down.
2. Washing the agar in distilled water for several days before adding to the wort.
3. Sterilizing in flowing steam by the discontinuous method.

Wort agar prepared according to Lund, with the above modifications, gives a clear background, which is an important consideration when counting moulds and yeasts under the microscope.

Area of Microplate.

An area of 2 x 4 cm., twice that employed in the original Frost technique, has been found most suitable. This can be marked out with a wax pencil upon an ordinary 2.5 x 7.5 cm. slide.

Amount of Butter Plated.

For the first series of tests 0.1 cc. of a 1:10 dilution of butter was plated on a 2 x 4 cm. area. In order to reduce the lower limit of counting, this was changed, and 0.2 c.c. of a 1:5 dilution was plated upon the same area. This reduced the previous lower limit from 2000 to 500, when 20 fields were counted.

Microplates prepared using larger quantities of diluted butter, or a lower dilution than 1:5, have been distinctly less satisfactory; in the latter case in particular, trouble arises from deposits of fat upon the microplate obscuring and making difficult the counting of mould and yeast colonies.

Microscopic Factor.

The microscopic factor expresses the relation between the area of the microscopic field and the area of the microplate. In the work reported here, a factor of 400 was found convenient for calculating results. This was obtained by adjusting the diameter of the field under the 16 m.m. objective to 1.6 m.m., from which the area is calculated by the formula;—

$$\text{Area} = \pi r^2$$

$$\pi r^2 = 3.1416 \left(\frac{1.6}{2}\right)^2 \text{ m.m.}$$

$$= 3.1416 \times .64 \text{ m.m.}$$

$$= 2.01 \text{ m.m.}^2 \text{ or approximately } 2 \text{ m.m.}^2$$

The area of the microplate being 800 m.m.^{2} (20 x 40 m.m.) the microscopic factor is

$$\frac{800}{2} = 400$$

Counting.

With the majority of samples analysed, the counting of twenty fields on the microplate gives sufficient accuracy for routine work, where rapidity and convenience are more important than extreme accuracy. Tests where various numbers of fields have been counted have rarely shown any significant change through the counting of more than twenty fields. The case of low count butter provides an exception; here it is advisable to increase the number

to forty. Also should the yeast count exceed fifty colonies per field, the counting of ten fields will suffice.

After a rapid preliminary survey to determine the evenness of distribution of the colonies, twenty representative fields are counted, preferably with the aid of a mechanical stage. Counts on duplicate microplates are then averaged, and moulds and yeasts per c.c. of butter calculated from the formula.

$$\frac{A}{B} \times X \times Y \times Z = N$$

where A = number of colonies observed
B = " " fields counted
X = reciprocal of dilution
Y = " " quantity plated
Z = microscopic factor
N = number of moulds (or yeasts) per c.c.

For example, if the average of duplicate microplates showed 10 moulds and 30 yeasts on 20 fields we would have

$$\frac{10}{20} \times 5 \times 5 \times 400 = 5{,}000 \text{ moulds per c.c.}$$

$$\frac{30}{20} \times 5 \times 5 \times 400 = 15{,}000 \text{ yeasts per c.c.}$$

This calculation can be greatly simplified by determining the number of moulds (or yeasts) per field $\left(\frac{A}{B}\right)$ and multiplying by 10,000 (X x Y x Z) to obtain the number per c.c. of butter (N). Where 40 fields are counted, the lower limit is $\frac{<1}{40} \times 5 \times 5 \times 400 = <250$ per c.c.

This lower limit could be reduced to <125 c.c. by employing an ocular which would give a field with a diameter of 2.25 m.m. One was not available for the work reported here, but there seems no reason why it should not prove satisfactory.

Plating Butter vs. Plating Serum.

With a view to further simplifying this technique for field work by dispensing with dilutions, counts were obtained on 50 samples of butter by (a) the standard plate method, (b) the microplate method (1:5 dilution) and (c) the microplate method, plating 0.2 c.c. of the curd-brine serum which separates from the butterfat on melting. The results appear in Table 1. Comparing results by the two microplate methods we see that (1) the mould counts by the butter dilution method showed less variation from the counts by the standard plate method; (2) in 35 instances the yeast count by the serum method was abnormally high, while in 19 cases the butter dilution method was abnormally low, as compared with the standard plate counts.

In addition, the serum microplates frequently show a murky background, making it difficult to count mould or yeast colonies when these are small or lightly stained; after eighteen hours incubation, *O. lactis* colonies on the serum microplate often have disintegrated into spores, rendering counting more difficult, especially if there are two or more colonies present per field.

TABLE 1.—*Relation of standard plate counts to counts obtained by plating butter dilutions and serum by micro-plate method*

	Standard Plate		Micro-plate (Serum)		Micro-plate (Butter)	
	Moulds	Yeasts	Moulds	Yeasts	Moulds	Yeasts
3/1	13,700	x	88.000	10,000	44,000	6,000
BD	8,250	16,000	x	91,400	20,000	500
BB	6,000	117,750	x	328,800	11,000	19,250
8Xa	5,750	403,000	39,000	3,130,000	8,750	251,000
A2	5,650	590,000	34,000	5,460,000	12,250	226,000
BC	5,000	124,500	x	538,400	17,250	21,750
A4	4,450	138,500	67,500	707,500	9,500	228,000
A5	3,325	166,250	24,300	202,000	6,250	110,000
6/12	3,200		12,530		8,000	
A6	2,500	357,000	19,500	4,426,000	5,500	666,000
7XA	925	1,600,000	8,000	8,800,000	1,500	1,663,000
AN	778	445,000	5,000	x	2,250	520,000
6J	725	2,000,000	20,000	x	2,500	1,718,000
BK	700	x	191,500	x	5,000	2,118,000
67	475	730,000	20,000	x	2,750	622,000
5/2	350	18,000	1,050	295,200	750	250
BG	300	20,500	1,550	x	750	50,250
BM	240	42,500	1,900	x	750	52,750
5/7	75	34,000	<50	225,600	250	43,500
5/6	50	38,500	<50	320,400	500	46,250
NZ13	35	400	100	15,200	<250	<250
BP	28	180	<100	1,300	250	<250
61	25	x	<250	x	250	1,916,000
6B	15	139,500	<250	x	333	<250
A3	13	600	<100	16,100	500	250
NZ–28	10	330	300	7,400	<250	375
BE	10	4,525	<100	22,700	<250	4,000
6A	5	180,000	250	x	<250	330
6C	5	9,750	<250	23,200	<250	333
6F	5	25,200	<250	154,400	<250	21,750
6G	5	26,000	<250	320,800	125	<250
6H	5	210,000	<250	x	<250	625
NZ–8	5	145	200	1,300	<250	375
BF	5	155	<500	<500	<250	<250
BQ	5	83	<100	1,100	<250	125
BR	5	20	50	150	250	<250
BU	5	233	<125	<125	125	750
NZ–1	3	563	<100	9,600	<250	250
NZ–1x	3	695	200	11,700	<250	375
5/12	<50	345,500	<50	622,800	<250	157,750
5/11	<50	251,000	<50	524,800	<250	145,000
5/10	<50	120,500	<50	209,200	<250	50,000
5/3	<50	100,000	50	540,800	500	500
5/1	<50	71,750	50	510,400	500	500
5/5	<50	26,250	<50		500	55,000
5/8	<50	21,500	<50	249,200	250	38,250
5/9	<50	750	<50	2,400	500	250
GE	<10	147,000	750	72,000	<250	33,000
GD	<5	140	<250	900	<250	<250
BS	<5	13	<125	<125	125	<250
BT	<5	43	<125	<125	125	750

Note: x—Too numerous to count.

The butter dilution technique appears then to be the most satisfactory. However, the serum method may be used to advantage in field work, to obtain an indication of the extent of contamination with mould and yeasts.

The butter dilution method was used for all further work reported here.

Period of Incubation.

To determine the most suitable period, two series of experiments were conducted. In the first, ten microplates were made from the same dilution

of each butter sample, and incubated at 25°C. After six hours, two microplates were removed, dried down, stained and counted. This was repeated at the 9th, 12th, 15th, and 24th hour. Table 2 contains the results obtained in this series.

TABLE 2.—*Micro-plate counts from different incubation periods compared with standard plate counts.*

	6 hours	9 hours	12 hours	15 hours	24 hours	Aver.	Stand. P.C.
M	6,000	8,000	10,500	17,060	20,000	12,310	
N	11,000	12,500	14,500	21,000	23,500	16,500	
O	1,500	10,000	15,000	13,000	18,000	14,000	2,600
P	12,500	17,000	20,500	19,000	22,000	18,200	
Q	<2,000	<2,000	<2,000	<2,000	<2,000		<100
R	<2,000	<2 000	<2,000	<2.000	<2,000		<100
		The above counts are for moulds only					
EA(M)	500	7,500	7,750	7,750	7,000	6,100	5,825
" (Y)	<250	16,250	35,750	47,000	56,750	31,200	715,000
EB(M)	750	12,250	15,000	12,000	14,000	10,800	11,500
" (Y)	9,750	57,500	71,000	123,750	348,500	122,100	x
EC(M)	7,750	14,500	16,250	18,000	19,500	15,200	15,250
" (Y)	x	x	x	x	x	x	x
ED(M)	2.500	5,250	5,500	7,500	6,750	5,500	3,900
" (Y)		3,750	27,750	65.000	508,750	121,050	300,000
EE(M)	250	500	2,500	3,000	3,250	1,900	700
" (Y)	500	23,000	169,000	311,750	412,750	183,400	63,000
EF(M)	750	7,750	8,000	7,750	7,500	6,350	2,750
" (Y)	x	x	x	x	x	x	x

Note: x—Too numerous to count.
(M)—Moulds
(Y)—Yeasts

With some samples, it appears possible to obtain a fair idea of the mould content within 6 to 9 hours, with others, germination of spores is slower, and there is a progressive increase up until 12 or 15 hours. Satisfactory yeast counts cannot be obtained much under 15 hours, when the colonies have attained sufficient size to show up distinctly when stained. It is worthy of note that in two cases the yeast count at 24 hours is considerably higher than that at 15 hours.

In the second series, the microplates were prepared as in the first, duplicate plates being removed and counted after 15, 18, 21 and 24 hours. Table 3 contains the data obtained. On the whole, differences in count due to length of incubation period are not significant, being rarely greater than the differences between duplicate plates prepared by either the standard plate or the microplate method. As in Table 2, in a few instances the longer period gives a higher yeast count, but the disintegration of *O. lactis* after 18 hours renders counting more difficult.

Summing up, and bearing in mind the matter of convenience in routine work, in addition to the results noted above, it may be stated that, for mould counts, a period between 12 and 18 hours is most satisfactory; for yeast counts, from 18 to 24 hours gives the highest counts. In many cases, it is possible to obtain valuable information regarding the mould content in from 6 to 9 hours.

Temperature of Incubation.

Among previous workers opinion seems divided as to the optimum incubation temperature for moulds and yeasts. Nicholls *(14)* states that *O. lactis* grows best at 35°C. Hunziker *(15)* also recommends this tem-

TABLE 3.—*Micro-plates from different periods of incubation compared with standard plate counts.*

	15 hours	18 hours	21 hours	24 hours	Aver.	Stand. P.C.
AK(M)	6,750	6,500	8,250	6,500	7,000	3,650
" (Y)	844,000	785,000	794,000	763,000	796,500	450,000
AL(M)	12,000	13,000	12,500	10,000	11,875	6,625
" (Y)	1,135,000	1,272,000	1,258,000	1,232,000	1,224,250	680,000
AM(M)	2,500	2,750	2,250	2,500	2,500	475
" (Y)	190,000	622,000	1,012,000	839,500	665,875	730,000
AN(M)	3,000	2,250	2,750	2,750	2,688	778
" (Y)	?	520,000	453,000	603,000	525,333	445,000
AO(M)	3,500	3,750	3,500	5,150	3,950	2,625
" (Y)	16,000	26,750	16,750	70,750	32,563	500,000
AP(M)	3,500	5,250	5,500	5,250	4,875	3,125
" (Y)	36,000	29,000	31,750	52,750	37,375	575,000
AU(M)	6,500	9,750	9,000	8,250	8,375	2 275
" (Y)	87,500	93,750	113,750	118,500	103,375	37,850
AV(M)	13,250	12,000	11,000	10,750	11,750	4,575
" (Y)	6,500	6,250	10,500	8,750	8,000	35,500
AW(M)	13,750	11,750	9,500	10,250	11,312	7,350
" (Y)	80,750	61,750	73,500	70,500	71,625	131,000
AX(M)	12,500	10,000	11,000	8,750	10,562	2,900
" (Y)	92,500	102,300	97,750	92,250	96,250	27,500
BA(M)	14,500	10,250	?	11,500	12,083	8,500
" (Y)	294,250	245,500	?	89,000	209,583	400,000
BB(M)	10,500	11,000	8,000	7,750	9,312	6,000
" (Y)	13,250	19,250	17,750	21,000	17,800	117,750

perature. The American Association of Creamery Butter Manufacturers *(16)* use 37°C. Stiritz *(17)* and Redfield *(8)* consider 30°C. the optimum, while Lund *(2)* used 25°C. and Bouska and Brown *(1)*, room temperature. To ascertain the optimum for the microplate method, several series of experiments were conducted which finally narrowed down to a comparison between 25° and 30°C. In the final series, 24 samples were plated out by both standard plate and microplate methods, 4 plates and 4 microplates being prepared from each dilution. Two of these were held at 25°C. and the other two at 30°C. The results appearing in Table 4 show considerable variation but the 25°C count exceeds the 30° count twice as often as the reverse is true. In addition, the mould and yeast colonies stand out more clearly on the 25° microplates than on those at 30°, when incubated 16 to 18 hours. 25°C. was therefore taken as the most suitable incubation temperature.

Detailed Description of Technique.

Samples of butter are obtained by drawing three or four plugs with a sterile trier, discarding the top ½ inch in each case, and transferring the remainder to a sterile sample jar. Jars are set in a water bath at 40-45°C. until melted. When completely melted, sample is shaken vigorously for 30 seconds, and a 10 c.c. portion withdrawn with a sterile warmed pipette. After removing the butter from the outside of the pipette with a sterile cloth or paper, the contents are delivered into a dilution bottle containing 40 c.c. of sterile water warmed to 45°C. (A 250 c.c. Erlenmeyer flask may be substituted for a dilution bottle; or 2 c.c. of butter may be added to 8 c.c. of water in a 16 x 150 m.m. test tube. These substitutes are less convenient for shaking and mixing).

While the samples are melting, an area of 2 x 4 c.c. is marked out upon clean microscopic slides with a wax pencil, as shown in Fig. 1. A small metal box or tank insulated upon the sides and bottom is filled with water

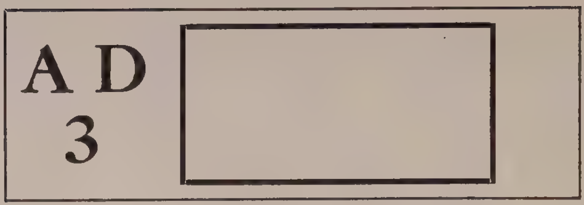


Figure 1.

Table 4.—*Mould and yeast counts from plates incubated at 25° C. compared with counts from plates incubated at 30° C.*

	Standard Plate Counts		Micro-plate Counts	
	25°	30°	25°	30°
CAB (M)	<50	<50	<250	<250
" (Y)	10,000	5,000	375	<250
CCD (M)	50	50	<250	375
" (Y)	33,500	18,000	2,250	875
CEF (M)	100	50	<250	125
" (Y)	36,000	21,000	625	1,375
CGH (M)	100	<50	250	125
" (Y)	20,000	650	<250	<250
CIJ (M)	41,500	68,500	70,000	115,000
" (Y)	5,000	<500	<2,000	5,000
CKL (M)	1,000	300	3,500	2,000
" (Y)	530,000	292,500	1,083,000	753,000
CMN (M)	15,000	17,000	39,750	36,750
" (Y)	750	<500	<250	250
COP (M)	21,000	12,500	19,750	32,750
" (Y)	145,000	145,000	32,750	29,500
CQR (M)	2,550	1,550	3,250	3,000
" (Y)	1,550	300	<250	<250
CST (M)	300	150	250	1,250
" (Y)	170,000	114,500	61,000	24,000
CUV (M)	91,500	72,500	150,000	135,000
" (Y)	3,500	1,000	500	1,000
CWX (M)	4,500	4,500	2,500	2,750
" (Y)	x	x	2,220,000	1,975,000
DAB (M)	14,000	10,500	18,250	14,500
" (Y)	x	x	2,385,000	1,775,000
DCD (M)	8,500	13,000	18,000	13,500
" (Y)	x	x	730,000	357,500
DEF (M)	11,000	12,000	16,250	12,000
" (Y)	x	x	1,291,000	856,000
DGH (M)	250	100	250	250
" (Y)	x	x	1,818,000	828,000
DIJ (M)	25,500	19,500	45,000	35,000
" (Y)	x	x	5,040,000	4,660,000
DKL (M)	16,500	19,000	30,000	25,000
" (Y)	x	x	295,000	240,000
DMN (M)	16,000	10,000	8,750	15,750
" (Y)	x	x	203,000	188,000
DOP (M)	9,000	10,500	16,750	20,500
" (Y)	x	x	1,027,000	700,000
DQR (M)	7,000	10,500	12,000	11,500
" (Y)	x	x	965,000	1,050,000
DST (M)	1,200	1,850	2,500	2,000
" (Y)	x	x	4,000,000	2,455,000
DUV (M)	41,000	33,500	46,500	39,500
" (Y)	x	x	1,690,000	1,590,000
DWX (M)	15,500	14,500	13,500	11,500
" (Y)	x	x	1,222,000	636,000

Note: x—Too numerous to count.

at 45°C; this is used as a "warm table" to prevent hardening of the agar medium before it can be mixed with the diluted butter being plated. A tube of previously melted wort agar acidified with sterile lactic acid to pH 3.5 to 4.0* is placed in the water through a hole in the top of the warm table, to maintain the proper temperature.

Duplicate slides are flamed and placed upon the surface of the warm table. The dilution bottle is shaken vigorously for 30 seconds, and a 1 c.c. pipette, graduated in tenths, filled to the upper graduation. After wiping off the exterior with a sterile cloth or paper, 0.2 c.c. are delivered on to the marked area of each slide. Four drops of agar are added to each, thoroughly mixed with the diluted butter, and spread evenly over the area with a sterile needle. The microplates are removed to a cold level surface and covered to protect them from air contamination while hardening. When hardened they are transferred to a sterile moist chamber for incubation. (A convenient form of moist chamber is listed by the Central Scientific Co. for milk analysis with the Frost technique). An incubation period of 12 to 18 hours at 25°C. has been found most suitable, and fits in well with ordinary laboratory routine. Where a shorter period must be used, it is advisable to raise the temperature to 30°C.; conversely, with a period in excess of 18 hours, a lower temperature is desirable.

At the conclusion of the incubation period the microplates are removed and "dried down" upon a metal sheet placed over boiling water. This should take between 5 and 10 minutes. When dried the microplates are immersed in a thionin solution made up as follows:

†Thionin	1 gram
Carbolic acid	2½ grams
Distilled water	400 c.c.

Filter, and add 5% of glacial acetic acid. No preparatory fixation is necessary, as the acid in the solution prevents the agar from staining too deeply.

Slides are stained for 3 minutes, then carefully washed, dried and examined under the 16 mm. objective. The microscope should be so adjusted that the area of the field with this objective will be 2 mm². For detailed instructions re counting, see "Counting" p. 355.

The technique described enables counts up to 50,000 moulds and 1,000,000 yeasts per c.c. to be obtained from 1:5 dilution.

INVESTIGATIONAL. PART II.

Comparison of the Microplate with the Standard Plate Method

In a comparison of the microplate with the standard plate method, the reliability of the former method is the feature of paramount importance; it must afford a reasonably accurate indication of the mould and yeast content of the butter analysed. We have no means of determining the exact number of moulds and yeasts present, for the standard plate count itself, like the official plate count in milk analysis, is far from being an exact measure. Nevertheless it is necessary that the standard plate method be taken as the standard with which the microplate method is to be compared. Part 2, Investigational records the results obtained from such a comparison.

* Recent work by the American Dairy Science Association Committee on Methods for the Bacteriological Analysis of Butter has shown pH 3.6 to be the most suitable reaction.

† Conn (18) states that care should be taken to obtain Thionin, (synonym Lauth's Violet) and not Thionin Blue, as originally erroneously specified by Frost.

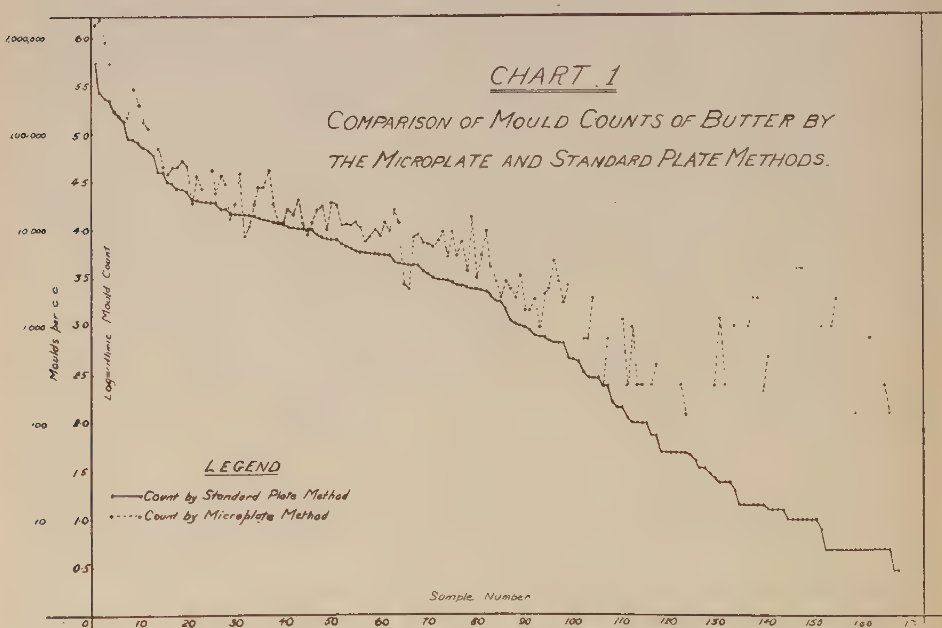
Reliability and Accuracy.

In comparing the microplate method, as described in Part 1, with the standard plate method now in use, 186 samples of butter were plated out simultaneously by both methods. These included lots from Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Zealand and Australia, with mould counts, by the standard plate method, ranging from 3 to 540,000 per c.c. and yeast counts from <5 to 2,000,000 per c.c. Having in mind the use of the microplate method chiefly for the detection of butter with a high mould count, as many samples of this class as possible were secured, and less attention was paid to low count butter, or to the yeast content.

To eliminate certain possible sources of error, all standard plates and microplates were prepared from the same dilution, or set of dilutions; media from the same flask was used for both lots, and all plates were incubated at the same temperature.

In Table 5 data is presented covering 128 samples on which it was possible to compare the mould counts by both methods. In each case, the ratio of the microplate mould count to the standard plate mould count has been calculated. In Chart 1 the mould count data is presented in graphical form.

CHART 1.



Here the logarithmic values of counts obtained by both methods have been plotted upon the Y axis, the samples being arranged in decreasing numerical sequence of standard plate mould count along the X axis. The advantages of using logarithmic in place of arithmetical values in making such a comparison have been fully set forth by Field (*19*) and others. In addition, a glance at the range covered by the counts in Table 5 shows the impossibility of satisfactorily presenting these arithmetical values in a single graph.

TABLE 5.—*Comparison of microplate counts with standard plate counts.*

	Standard Plate Counts		Microplate Counts		Mould Ratio
	Moulds	Yeasts	Moulds	Yeasts	1:
1/I	541,000		1,380,000		2.5
1/P	278,500		1,510,000		5.4
1/Q	237,000		900,000		3.8
1/E	225,000		540,000		2.4
C/UV	91,600	3,500	150,000	500	1.6
1/D	90,500		290,000		3.2
1/C	78,500		200,000		2.5
CV	72,500	1,000	135,000	1,000	1.9
CI	68,500	<500	115,000	5,000	1.7
CJ	41,500	5,000	70,000	2,500	1.7
DU	41,000	x	46,500	1,690,000	1.1
DV	33,500	x	39,500	1,590,000	1.1
1/A	30,500		46,800		1.5
4/Q	28,000		47,200		1.7
1/F	26,500		54,000		2.0
DI	25,500	x	45,000	5,040,000	1.8
CO	21,000	145,000	19,750	32,750	0.9
1/G	20,500		36,800		1.8
4/R	19,500		27,000		1.4
DJ	19,500	x	35,000	4,660,000	1.8
1/K	19,175		43,000		2.2
DL	19,000	175,000	25,000	240,000	1.3
CN	17,000	<500	36,750	250	2.1
DK	16,500	x	30,000	295,000	1.8
DW	15,500	x	13,500	1,222,000	0.9
EC	15,250	x	18,000	x	1.2
CM	15,000	750	39,750	<250	2.6
DM	15,000	x	8,750	203,000	0.6
DX	14,500	x	11,500	636,000	0.8
DA	14,000	x	18,250	2,385,000	1.3
1/A	13,700		44,000		3.2
DD	13,000	x	13,500	357,500	1.0
1/J	12,650		45,000		3.6
CP	12,500	145,000	18,000	29,500	1.4
DF	12,000	x	12,000	856,000	1.0
EB	11,500	x	12,000	71,000	1.0
DE	11,000	x	16,250	1,291,000	1.5
DB	10,500	x	14,500	1,775,000	1.4
DP	10,500	x	20,500	700,000	2.0
DR	10,500	x	11,500	1,030,000	1.1
8/X3	10,100	715,000	9,000	241,500	0.9
DN	10,000	x	15,750	188,000	1.6
DO	9,000	x	16,750	1,027,000	1.8
DC	8,500	x	18,000	780,000	2.1
BA	8,500	400,000	10,250	245,500	1.2
BD	8,250	16,000	20,000	500	2.4
3/P	8,200		18,200		2.2
7/AW	7,350	131,000	11,750	61,750	1.6
DQ	7,000	x	12,000	965,000	1.7
6/AL	6,625	680,000	11,500	1,187,000	1.7
8/Y2	6,250	345,000	12,500	367,000	2.0
7/BB	6,000	117,750	11,000	19,250	1.8
EA	5,825	715,000	7,750	47,000	1.3
8/Y1	5,750	403,000	8,750	251,000	1.5
8/X2	5,725	470,000	10,500	271,000	1.8
8/X4	5,675	486,000	9,000	245,100	1.6
8/X1	5,650	590,000	12,250	226,000	2.1
8/Y4	5,500	350,000	10,000	250,000	1.8
7/BC	5,000	124,500	17,250	21,750	3.5
AV	4,575	35,500	12,000	6,250	2.6
CX	4,500	x	2,750	1,975,000	0.6
CW	4,500	x	2,500	2,220,000	0.6
8/Y3	4,500	385,000	8,500	310,500	1.9

(Table 5 continued overleaf)

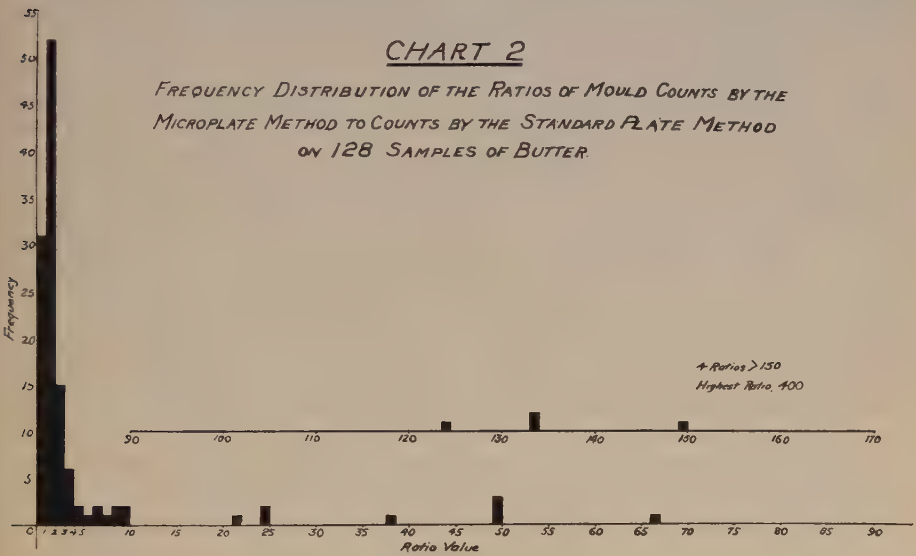
TABLE 5.—*Continued.*

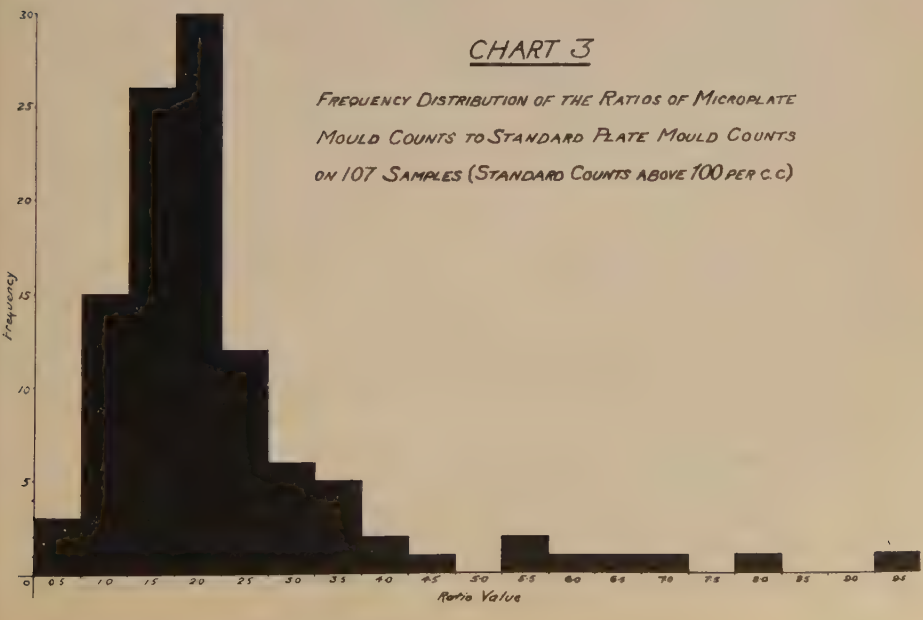
	Standard Plate Counts		Microplate Counts		Mould Ratio
	Moulds	Yeasts	Moulds	Yeasts	1:
8/V2	4,450	138,500	9,500	228,000	2.1
ED	3,900	300,000	7,500	65,000	1.9
6/AK	3,650	450,000	7,250	1,207,000	2.0
8/U2	3,325	166,250	7,000	53,500	2.1
1/B	3,200		8,000		2.5
8/V1	3,150	127,750	10,250	232,500	3.2
7/AP	3,125	575,000	5,250	29,000	1.7
7/AX	2,900	27,500	10,000	102,500	3.4
8/U1	2,750	130,250	5,500	166,250	2.0
EF	2,750	x	7,750	x	2.8
7/AO	2,625	500,000	3,750	26,750	1.4
3/O	2,600		14,000		5.4
8/T1	2,550	1,550	3,250	<250	1.3
	2,500	357,000	5,500	666,000	2.2
7/AO	2,275	37,850	9,750	93,750	4.2
8/T2	2,100	555,000	4,250	924,000	2.0
2/D	1,000		3,000		1.6
DT	1,850	x	2,000	2,455,000	1.1
CR	1,550	300	3,000	<250	1.9
DS	1,200	x	2,500	4,000,000	2.1
2/A	1,100		2,000		1.8
CK	1,000	530,000	3,500	1,083,000	3.5
8/24	975	1,720,000	1,500	877,000	1.5
8/Z1	925	1,600,000	1,500	1,663,000	1.6
BN	825	x	2,000	2,080,000	2.4
8/Z23	800	1,470,000	1,000	486,000	1.3
7/AN	778	445,000	2,250	520,000	2.9
6/AJ	725	2,000,000	2,500	1,718,000	3.3
8/BK	700	x	5,000	2,118,000	7.1
EE	700	63,000	3,000	311,750	4.3
8/Z2	675	1,840,000	1,750	1,668,000	2.6
7/AM	475	730,000	2,750	622,000	5.8
6/Z	438	25	750	<250	1.7
5/B	350	18,000	750	250	2.1
8/BG	300	20,500	750	50,250	2.5
CL	300	292,500	2,000	753,000	6.6
CS	300	170,000	250	61,000	0.8
DG	250	x	250	1,818,000	1.0
8/BM	240	42,500	750	52,750	3.1
CT	150	114,500	1,250	24,000	8.0
4/V	115		250		2.2
4/C	105		1,000		9.5
DH	100	x	250	828,000	2.5
CG	100	20,000	250	<250	2.5
5/G	75	34,000	250	43,500	3.3
5/F	50	38,500	500	46,250	10.0
CD	50	18,000	375	875	7.5
CF	50	21,000	125	1,375	2.5
8/BP	28	180	250	<250	8.9
5/D	25	23,750	1,250	57,000	50.0
6/A1	25	x	250	1,916,000	10.0
4/P	15		1,000		66.7
4/A	15		1,000		66.7
4/J	15		2,000		133.3
4/K	15		2,000		133.3
6/AB	15	139,500	333	<250	22.2
8/N2	13	605	500	250	38.0
4/L	10		4,000		400.0
4/M	10		4,000		400.0
6/X	8	540	1,000	<250	125.0
4/N	5		1,000		200.0
4/O	5		2,000		400.0
6/AG	5	26,000	125	<250	25.0
8/W1	5	500	750	375	150.0
8/BR	5	20	250	<250	50.0
8/BU	5	233	125	750	25.0

Note: x—Too numerous to count.

Chart 1 effectively depicts the salient features of the comparison. With the higher count butter there appears a distinct parallelism, but as the count approaches the lower limit of the microplate method there is a tendency to wider variation, which increases markedly after passing the equivalent of 100 moulds per c.c. by the standard plate method. With the microplate method, one mould encountered in 20 fields examined gives a mould count of 500 per c.c. Because of this, it is perhaps best to state the equivalent of a standard plate count of 100 per c.c. as the lowest reliable limit for the microplate technique here described.

In Chart 2, the frequency distribution of the ratios of microplate mould counts to the standard plate mould counts on 128 samples has been plotted.





In this, the grouping of the ratios about the modal value of 2:1 is significant; 77.37% fall between 1:1 and 3:1 with 41.47% in the modal value itself. If only those samples showing a mould count of over 100 per c.c. by the standard plate method are considered, the frequency distribution is much closer to the normal as is shown by Chart 3. Here the widest ratio is 9.5 : 1, with 78.5% between 1 : 1 and 2.5 : 1 inclusive.

From the results reported here, it would appear that the ratio of mould counts by the microplate method to counts by the standard plate method is approximately 2:1. The microplate technique should be checked over a larger number of samples and by different workers before this ratio can be finally accepted for interpreting microplate counts in terms of the standard plate method.

Perhaps a word should be said as to the reason for the higher counts by the microplate method. In counting under the microscope, the mycelium of each mould, resulting from the germination of a single spore, is counted; on the standard plates, a mould colony, which after five days generally has a diameter of more than 1 cm., may have resulted from the germination of two or more spores. Again, where the standard plate is crowded, either with moulds or yeasts or both, the growth of the weaker mould colonies may be inhibited, and the count will be lower than it should be. Evidence of this is given in the higher counts obtained from plates poured from the higher dilutions, as compared with the more crowded plates of the lower dilution. The claim may therefore be made that the microplate method affords a more accurate indication of the actual mould content of the butter than does the standard plate method.

Another point in support of the above contention is that with the high count butter, a larger quantity of the butter is plated on the microplate (0.04 c.c.) than on the 1:100 dilution standard plate (0.01 c.c.). This no doubt explains why the counts from duplicate microplates vary much less than those from standard plates of the higher dilutions. The possibility of results being disturbed by mould contamination from the air is also greater with the standard plate method, due to the greater dilutions employed, even though the microplate is exposed to the air for perhaps thirty seconds during plating.

When the yeast counts obtained by the microplate method are compared with the standard plate counts, a less satisfactory correlation is observed. In several cases, the microplate count is very low in comparison with the standard plate count. In explanation of these discrepancies, a number of reasons suggested themselves. In the first place, it was thought that insufficient shaking of the dilution when preparing the microplates might be the cause, but experiments failed to substantiate this. The next idea which suggested itself was that in using the graduated 1 c.c. pipette to deposit 0.2 c.c. upon the slide, the yeasts might rise to the top with the butterfat within the bore of the pipette, and thus escape being plated out. Tests disposed of this possibility also.

Two other possibilities suggest themselves. One is that in these particular samples, the majority of the yeasts had a very low thermal death-point, and could not stand being held at 45°C. for thirty to forty minutes between the plating out on the standard plates and the preparation of the microplates. The second possibility is that the yeasts in those particular samples were

very slow growing, and were unable to form recognisable colonies upon the microplates during the fifteen to eighteen hours incubation at 25-30°C. This was supported by an examination of the standard plates of several of these samples showing discrepancies, which revealed the presence of large numbers of small subsurface colonies at the end of the incubation period. Unfortunately, neither of these conjectures could be confirmed by experiment, as the samples of butter involved had been discarded to make room for fresh ones before the discrepancy in yeast counts became known.

In connection with the explanation based upon slowness of growth, it is interesting to note that in one of the experiments where microplates were counted after six, nine, twelve, fifteen and twenty-four hours of incubation, (Table 2), the yeast count jumped from 65,000 at 15 hours, to 508,750 at 24 hours, while the standard plate gave a count of 300,000 yeasts per c.c. In addition, it should be noted that, with some samples of butter, it is difficult to obtain microplates with as clear a background as is desirable. This renders it difficult to count very small or lightly stained yeast colonies under the microscope, resulting in a lower yeast count by the microplate method.

Even though the yeast count is of secondary importance in the detection of butter with a high mould content, nevertheless it is desirable that more work be done to determine definitely the cause of the discrepancies between yeast counts by the two methods.

Despite the greater irregularity of the yeast counts (which are still a great deal more reliable than those obtained by workers using the Breed direct microscopic method,) we may safely conclude that the microplate method will give reliable and accurate results in the detection of butter with a high mould content.

Summary and Conclusions.

In order that counts of moulds and yeasts in creamery butter may be obtained in less time than with the present standard plate method, a rapid method, known as the Microplate Method, has been evolved. This method, which is a modification of the Frost little plate method of milk analysis, enables counts to be obtained in from one-seventh to one-tenth of the time required by the standard plate method.

Samples from 186 lots of butter from various sources have been analysed by both the microplate and the standard plate methods, and the results compared. A study of the data obtained leads to the conclusion that the microplate method can be relied upon to furnish a reasonably accurate indication of the mould content of the butter, where this is above 100 per c.c. as determined by the standard plate method. This figure may be regarded as the minimum working limit of the new method.

On the average, mould counts obtained by the microplate method are twice as great as those obtained by the standard plate method. The reason for this higher count is that with the microplate method, each individual colony resulting from the germination of a spore can be counted, while with the standard plate method, two or three spores may germinate and grow together to form a single colony.

A frequency distribution of the ratios of the counts obtained by the microplate method to those by the standard plate method shows a close grouping about the modal value of 2 : 1. More work is necessary in order to verify this as the most common average between counts by the two methods.

Yeast counts obtained by the microplate method showed greater variability, due to factors not fully determined. However, a satisfactory relationship between the counts by the two methods was obtained on 74.6% of the samples analysed.

In addition to the saving of time already referred to, the microplate method is more economical of glassware, media, equipment and labor, and can be readily adapted to field work.

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LITERATURE CITED

1. Bouska, F.W. and Brown, J.C. The significance of yeasts and *Oidia* in pasteurized butter. Univ. of Wisconsin Studies in Science, No. 2. 131-138. 1921.
2. Lund, T.H. Yeasts and Moulds in butter. 44th Annual Report, Ont. Agr. College, 39-41, 1918.
   ——— Notes on yeast and mould counts on creamery butter. Dairymen's Ass'n Ont. Ann. Report, 1919, 90-94.
   ——— Microorganisms in creamery butter. Sci. Agr. *2*; 10, 332-340. 1922.
3. Brown, C.W., Smith, L.M. and Ruehle, G.L.A. A bacteriological and biochemical study of experimental butters. Jour. Dairy Sci. *3*; 5, 375-405, 1920.
4. Grimes, M. A study of the action of certain bacteria, yeasts and molds on the keeping quality of butter in cold storage. Jour. Dairy Sci. *6*; 5, 427-445, 1923.
5. Hood, E.G. and White, A.H. The cause and prevention of mould in Canadian pasteurized butter. Dom. Dept. of Agr. Bul. 48, N.S. 1925.
6. Parfitt, E.H. Relationship between yeasts and molds in butter and the butter score and care in manufacture. Creamery & Milk Plant Monthly, *40*; 1, 1926.
7. Macy, H. Mold and yeast counts and their relation to the composition of butter. Jour. Dairy Sci. *10*; 5, 384-395, 1927.
8. Redfield, H.W. The determination of yeasts and *Oidia* in cream and butter. Jour. Dairy Sci. *5*; 1, 14-21, 1922.
9. Breed, R.S. and Brew, J.D. Counting bacteria by means of the microscope. New York (Geneva) Agr. Exp. Sta. Tech. Bul. 49, 1916.
   ——— The control of bacteria in market milk by direct microscopic examination. New York (Geneva) Agr. Exp. Sta. Bul. 443, 1917.
   Standard Methods of Milk Analysis, A.P.H.A. 4th Ed. pp. 11-16. 1923.
10. North, W.R. Jr. and Reddish, G.F. Yeasts and *Oidia* in high grade experimental butter. Jour. Dairy Sci. *4*; 6, 510-520, 1921.
11. Frost, W.D. A rapid method for counting bacteria. Jour. Inf. Dis. *19*; 273-287, 1916.
   ——— Improved technique for the little plate method of counting bacteria in milk. Jour. Inf. Dis. *28*; 176-184, 1921.
   Standard Methods of Milk Analysis, A.P.H.A. 4th Ed. pp. 11-16. 1923
12. Simmonds, J.E. A comparison with the standard plate method of some rapid methods for the bacteriological analysis of milk. Jour. Inf. Dis. *24*; 322-336, 1919.
13. Hatfield, H.M. and Park, W.H. A study of the practical value of the Frost little plate method in the routine colony count of milk samples. Am. Jour. Pub. Health, *12*; 478-487, 1922.
14. Nicholls, H.M. The deterioration of butter through the agency of *Oidium lactis*. Tasmania Agr. and Stock Dept. Bul. 86, 1919.
15. Hunziker, O.F. The butter industry. XXII,665 pp. 113 fig. O. F. Hunziker, LaGrange, Ill. U.S.A. 1920.
16. American Association of Creamery Butter Manufacturers. Personal communication to the author from Dr. G. L. McKay, Sec'y. April 15th, 1926.
17. Stiritz, B.A. Yeast and mold counts and their relation to pasteurization of cream for buttermaking purposes. Jour. Dairy Sci. *5*; 4, 362-371, 1922.
18. Conn, H.J. Thionin. Jour. Dairy Sci. *6*; 2, 135-136, 1923.
19. Field, J.A. Some advantages of the logarithmic scale in statistical diagrams. Jour. Pol. Econ. *25*; 805-841, 1917.

LEGEND FOR PLATE I.

Fig. 1. Field from microplate incubated 9 hours at 25°C.
Fig. 2. Field from microplate incubated 12 hours at 25°C.
Fig. 3. Field from microplate incubated 15 hours at 25°C.
Fig. 4 Field from microplate incubated 18 hours at 25°C.
Fig. 5. Field from microplate incubated 18 hours at 30°C.
Fig. 6. Field from microplate incubated 24 hours at 25°C.
Magnification X40 diameters.

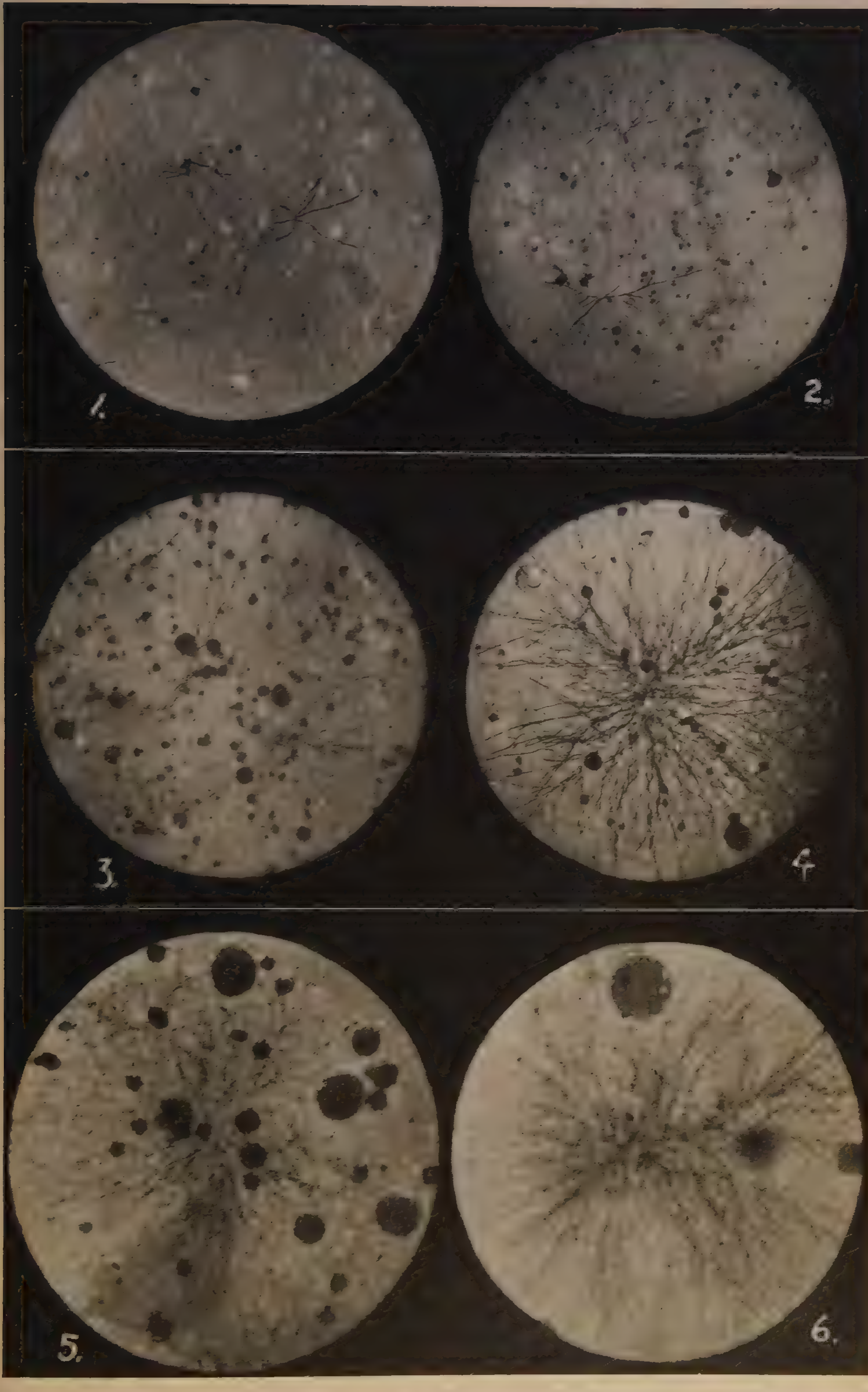

PLATE 1

OPTIMUM FEEDING TEMPERATURES FOR THE DARK-SIDED CUTWORM, *Euxoa messoria Harris* †.*

A. V. MITCHENER

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During the seasons of 1925 and 1926 several species of cutworms were involved in an outbreak on the Canadian prairies. Wheat, oats, barley, rye, flax and garden plants were attacked. Large fields of grain were eaten off and large and small gardens were more or less ruined. The damage done was considerable in amount and extent. In 1925 the dominant species throughout Manitoba was the Red-backed Cutworm, *Euxoa ochrogaster Gn.* In 1926 the Dark-sided Cutworm, *Euxoa messoria Harris* almost entirely replaced the former in the eastern part of the province. In the vicinity of Winnipeg the Red-backed Cutworm was relatively scarce, while the Dark-sided Cutworm was very abundant. Another Cutworm, *Polia lorea Gn.* was common, especially on alfalfa at Manitoba Agricultural College, Winnipeg, during 1926. This is a very early Cutworm appearing partly grown as soon as any food is available. This species ceased feeding in 1926 about the middle of May so that probably it will never be very destructive to cereal crops. The Dark-sided Cutworm, however, is one which develops late in the season. This species was first noticed as very small larvae about the middle of May. They continued to feed until about the fourth week in June. Thus it can be seen that this cutworm is capable of doing great damage to both field and garden crops. Specimens of other species were found in association with *Euxoa messoria* but only in limited numbers in the vicinity of Manitoba Agricultural College.

The usual recommendation given to farmers and gardeners is to use a poisoned bait. They are advised to scatter this bait on the infested area, or the area to be protected, in the evening as cutworms feed at night and it is desirable to have the bait fresh when they first begin to crawl about on the surface of the ground in search of food. Very little information is available as to the kind of night that is most suitable for feeding. During the early stages of the late grasshopper campaigns in Western Canada considerable poisoned bait was scattered upon the ground when it was ineffective. The weather conditions under which grasshoppers fed most readily were at that time unknown. When more information was available about the habits of grasshoppers, the cost of killing them was reduced materially as the poisoned baits were scattered when they would do the most good. When cutworms became so injurious it seemed possible that they might feed more readily under certain temperatures than others. This investigation was, therefore, undertaken to see if this was the case and if so to determine the optimum temperatures for feeding.

†Lepidoptera, Noctuidae.

*One section of a thesis presented to the Committee on Post-Graduate Studies at the University of Manitoba in partial fulfilment of the requirements for the degree of Master of Science.

The equipment used in the investigation consisted of a large ice refrigerator whose inside dimensions were 8′ x 6′ 2″ x 3′ 3½″, three electric ovens and covered tin boxes whose outside measurements were 4½″ x 2⅕″ x 1½″. The temperature of the refrigerator during the course of the investigation varied from 7°C. to 10°C. and averaged around 8.3°C.

The Dark-sided Cutworm was used as it occurred in numbers sufficiently great to supply all the living material needed. Cutworms were collected and placed in the laboratory in a large jar partly filled with sifted earth. These were given more food than they would eat over night. Food at all times during the investigation consisted of fresh alfalfa leaves and stems from the growing parts of the plants. The ends of stems which had a similar appearance were selected in all cases for food. In the afternoon following the night that the cutworms had eaten all they would take, units of 30 cutworms were counted out and placed in each tin box used in the experiment. Each tin box was about one-third filled with fresh soil which had been sifted through a sifter made from ordinary wire mosquito netting. The soil usually was somewhat damp as it was taken from the garden just before being placed in the tins. Soil moisture was practically constant in all tins for any particular day. Two or three grams of alfalfa leaves and stems were weighed out and placed in the tin box on the surface of the soil with the cutworms. A piece of white paper larger than the top of the box was then placed over the top and the cover pressed into position. In every case a check tin box, complete with all details except the cutworms, was used. One of these checks was placed in each warming oven and in the refrigerator itself each day beside the tin containing the cutworms. These were usually placed in their respective temperatures at approximately 5.00 p.m. each day and left there under constant temperature until about 9.00 a.m. the following morning. At this time each check for a certain temperature was weighed and the loss in weight noted. The loss in weight was due to evaporation of moisture from the alfalfa. This loss was higher at higher temperatures than at lower ones. The food left in each box of cutworms was then weighed and the loss noted. The loss in the weight of the check was deducted from this in order to determine the actual amount of food consumed by the cutworms during the night. Temperatures as well as actual food consumed by each lot of 30 cutworms were recorded. These cutworms which had been under observation during the night were all transferred to another large jar similar to the one first mentioned where they were fed all they would eat the next night. Cutworms from the large lots collected were never used until they had had an opportunity to eat all they wanted. In other words lots of cutworms were used each night which had eaten all they wanted the previous night under favorable feeding conditions. The difficulty of removing the cutworms from the soil each morning was overcome by using the sifter. The soil was run through the sifter and the cutworms remained on the screen. They were then dumped out on a piece of paper and then placed in the jar with the general supply. Each afternoon at least four lots and frequently as many as seven lots of 30 cutworms were used. Where more than four lots were taken duplicate lots were used under a certain temperature. For example two tins of

TABLE 1.—*Food consumed by cutworms at various temperature ranges.*

Date 1926	TEMPERATURE RANGE 7 °C to 10°C incl. 44.6°F to 50°F incl. — No. of lots of 30 cut-worms used	Total amount of food consumed by these cutworms	Average amount of food consumed by each lot of 30 cutworms	TEMPERATURE RANGE 20°C to 25°C incl. 68°F to 77°F incl. — No. of lots of 30 cut-worms used	Total amount of food consumed by these cutworms	Average amount of food consumed by each lot of 30 cutworms	TEMPERATURE RANGE 34°C to 39°C incl. 93.2°F to 102.2°F incl. — No. of lots of 30 cut-worms used	Total amount of food consumed by these cutworms	Average amount of food consumed by each lot of 30 cutworms
May 16–19 inclusive	5	.79 gms	.16 gms	5	1.55 gms	.31 gms	5	3.15 gms	.63 gms
May 20–23	7	2.60 gms	.37 gms	9	6.56 gms	.73 gms	3	4.65 gms	1.55 gms
May 24–27	8	3.80 gms	.47 gms	12	11.92 gms	.99 gms	8	14.48 gms	1.81 gms
May 28–31	8	8.64 gms	1.08 gms	15	28.78 gms	1.91 gms	4	5.40 gms	1.35 gms
June 1–4	4	5.95 gms	1.48 gms	4	9.15 gms	2.28 gms	5	9.85 gms	1.97 gms
June 8	1	1.9 gms	1.9 gms	1	2.25 gms	2.25 gms	2	2.2 gms	1.1 gms
June 9–12	5	7.15 gms	1.43 gms	3	4.95 gms	1.65 gms	5	4.2 gms	.84 gms

Note. Certain lots were discarded as they did not fall in the above temperature ranges.

TABLE 4.—*Time required for the dark-sided cutworm to succumb to poison.*

			No. of cutworms found dead at times stated below										
Date poison given	No. of cutworms	Poison in Bait	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	9th day	10th day	
June 9	30	Paris Green	1	3	4	5	3	5	0	1	1	0	
June 9	30	Paris Green	0	0	2	4	7	1	0	3	0	0	
June 10	30	Paris Green	0	2	2	3	3	2	0	0	1	1	
June 10	30	Paris Green	0	0	2	3	2	1	1	1	1	0	
June 15	30	Paris Green	2	1	0	3	0	0	1	0	2	0	
June 15	30	Paris Green	0	1	1	2	5	4	2	0	0	0	
Totals	180	Paris Green	3	7	11	20	20	13	4	5	5	1	89
June 9	30	Calcium Arsenate	0	0	3	2	7	5	4	0	0	0	
June 9	30	Calcium Arsenate	0	0	2	1	1	4	2	0	1	0	
June 10	30	Calcium Arsenate	0	0	1	5	3	5	2	1	3	0	
June 10	30	Calcium Arsenate	0	0	3	4	3	1	1	2	0	3	
June 15	30	Calcium Arsenate	2	0	2	0	0	0	1	2	0	0	
June 15	30	Calcium Arsenate	0	2	0	2	4	1	0	0	1	1	
Totals	180	Calcium Arsenate	2	2	11	14	18	16	10	5	5	4	87
Check	30		0	1	0	0	0	0	1	0	0	0	

Note. The baits used on June 15 were not freshly made.

cutworms each along with the check would be placed in the refrigerator at 9°C.

The investigation began May 13 and was carried on continuously until June 12, 1926, with the exception of three days, namely, June 5, 6 and 7 when absence from the College prevented records from being taken on those dates. In all, the feeding behaviour of 4110 cutworms of the species *Euxoa messoria* in so far as they could be selected at their various periods of growth was under observation during the investigation.

The data shown on Table 1 are compiled for four-day periods from May 16 to June 12 with the exception already noted. The temperature of the refrigerator varied from 7°C to 10°C during this period and this temperature range was used for one series for the period of the experiment. Two warming ovens ran with temperatures much alike and the data secured from these have been placed under a temperature range of 20°C to 25°C. The third warming oven where the temperature was not automatically controlled had a temperature range of 34°C to 39°C.

Altogether the effect of temperature upon the relative amounts of food consumed is shown for 3570 cutworms in this table. The temperatures at which certain other lots were held did not fall within any of the ranges shown in the table but rather between the respective ranges and consequently were not taken into consideration in the compilation.

TABLE 2.—*Food eaten nightly by cutworms from May 16 to June 12, 1926.*

Four Day Periods Date 1926	TEMPERATURE RANGE 7°C TO 39°C FOR ALL LOTS		
	Total No. of lots of 30 cutworms	Total food eaten by these cutworms	Average amount of food eaten by each lot of 30 cutworms
May 16–19 incl.	15	5.49 gms	.36 gms
May 20–23 incl.	19	13.81 gms	.72 gms
May 24–27 incl.	28	30.20 gms	1.07 gms
May 28–31 incl.	27	42.82 gms	1.58 gms
June 1–4 incl.	13	24.95 gms	1.91 gms
June 8	4	6.35 gms	1.58 gms
June 9–12 incl.	13	16.30 gms	1.25 gms

Cutworms were also subjected to both lower and higher temperatures than those shown in Table 1. On June 9 one lot of 30 cutworms was placed along with food in another refrigerator where the temperature was —5°C, and left there from 5.00 p.m. until 9 a.m. June 10. When they were removed all appeared lifeless. The alfalfa used as food was frozen. When they were examined again at 2.00 p.m. June 10 twenty showed evidences of life while ten of them seemed dead. It is interesting to note without going into detail that some of the cutworms which were subjected to this temperature revived, fed normally thereafter and went into the pupal stage. On June 10 another lot of 30 was subjected for 17 hours to –3°C with the result that 16 out of 30 were killed. The other fourteen revived. By June 20 only 6 of these cutworms remained alive. In both cases mentioned above no food had been eaten by the cutworms during their confinement. Lots of 30 cutworms were also subjected to high temperatures, namely, 41°C, 45°C and 46°C over night. In all cases all of the cutworms were

killed. The alfalfa used as food was browned by the heat and none had been eaten.

Two facts are brought out in the data shown in Table 1:

(1) There is a peak period to the food consumed by the Dark-sided Cutworm during its larval life.

(2) The Dark-sided Cutworm has preferences as to the temperature at which it will consume the most food. In order to see these facts more clearly the data are rearranged and shown in Tables 2 and 3.

In Table 2 the average amount of food eaten by each lot of 30 cutworms is shown for four day periods throughout the experiment. From May 16 when the cutworms were small until the first four days of June the amount of food consumed increased rapidly. At this latter period the cutworms nightly ate over five times the quantity of food that they consumed

TABLE 3.—*Average amount of food eaten by lots of 30 cutworms nightly during four day periods under different temperature ranges.*

	TEMPERATURE RANGES		
Date 1926	7 C to 10°C incl. 44.6°F to 50°F incl.	20°C to 25°C incl. 68°F to 77°F incl.	34°C to 39°C incl. 93.2°F to 102.2°F incl.
May 16–19 incl.	.16 gms	.31 gms	.63 gms
May 20–23 incl.	.37 gms	.73 gms	1.55 gms
May 24–27 incl.	.47 gms	.99 gms	1.81 gms
May 28–31 incl.	1.08 gms	1.91 gms	1.35 gms
June 1–4 incl.	1.48 gms	2.28 gms	1.97 gms
June 8	1.9 gms	2.25 gms	1.1 gms
June 9–12 incl.	1.43 gms	1.65 gms	.84 gms

during the middle of May. From early in June the amount of food consumed dropped away slowly. Under laboratory conditions we found that *Euxoa messoria* continued to feed until June 27 although towards the end of the period feeding was slight.

The second fact brought out by the data that the Dark-sided Cutworm has temperature preferences for feeding is more clearly seen in Table 3. The data in Table 3 show that in the early stages in the larval life of the Dark-sided Cutworm the warmer it is within natural limits, the more food they will consume. For example from May 16 until May 27 at a temperature range of from 20°C to 25°C these cutworms ate about twice as much as they did in the temperature range of 7°C to 10°C and further that at the temperature range 34°C–39°C they ate about twice as much as at the range 20°C–25°C. The inference is clear, therefore, that the higher the temperature is within natural limits at that season of the year the more food these cutworms will consume. At this point, however, a change begins to occur in the temperature preferences of the cutworms. The extremely high temperatures are no longer the most desirable ones for food taking. During the period May 28 – June 12 the most desirable feeding temperature range of those shown is 20°C–25°C. It is also noted that feeding goes on well at the lowest temperature range 7°C–10°C.

An attempt was also made while the above work was under way to determine the time required for poisons to kill cutworms. Paris green and

calcium arsenate were the stomach poisons used. Both were used with bran and also with alfalfa leaves as carriers for the poisons. The poisoned baits were left with the cutworms over night and removed in the morning in each case. Following this, each lot of cutworms was given fresh alfalfa daily throughout the experiment. Table 4 gives details and compares the relative usefulness of paris green and calcium arsenate as insecticides for the purpose of poisoning cutworms.

The paris green and calcium arsenate were used at the same rate in all the baits used. A study of this table reveals the fact that neither paris green nor calcium arsenate kill quickly. Although paris green kills slightly quicker than calcium arsenate the relative difference is not very great. Relatively few cutworms were dead before the end of the third day. For example the total number of cutworms killed by paris green by the end of the third day was only 21 out of a total of 89 killed. Nearly half of this total died on the fourth and fifth days after eating the paris green. The majority of the cutworms which died from the effects of eating calcium arsenate died on the fourth, fifth and sixth days. An observation of some considerable economic importance was made to the effect that once the cutworm took the poisoned bait it stopped feeding almost completely. Very little alfalfa was consumed by the cutworms which had fed on the baits even the first night after the poison had been taken. For all practical purposes, therefore, even though the poisoned cutworms did not die at once they did not do any further damage before they finally died. It will be noted further that only about 49% of the cutworms which fed upon or had an opportunity to feed upon the poisoned baits died within ten days. Some cutworms died after that time while others recovered. It is presumed that those which recovered regained their appetites.

Summary

1. In a normal year such as 1926 the maximum damage done by the Dark-sided Cutworm *Euxoa messoria* occurs about the first week of June.
2. This species continues to feed until near the end of June.
3. Until near the end of May the higher the temperature within natural limits the more the cutworms eat.
4. Beginning near the end of May and continuing into June the optimum feeding temperatures dropped to the range 20°C to 25°C (68°F to 77°F).
5. Paris green kills slightly quicker than calcium arsenate.
6. The maximum deaths for paris green occurred on the fourth and fifth days while for calcium arsenate they occurred on the fifth and sixth days.
7. Cutworms which have eaten poisoned bait stop feeding although they do not die for several days.

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AGRICULTURAL COOPERATION IN NEW YORK STATE.*

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For nearly a century New York farmers have been associated in some form of organized cooperative activity. The volume of business transacted by associations in New York State engaged in purchasing farm supplies and selling farm produce now amounts to about $100,000,000 annually. In other fields of agricultural cooperation it is difficult to measure the results in monetary terms but in the operation of fire insurance companies, telephone companies, credit organizations and in other cases the principle of cooperation has been successfully applied for many years.

As early as 1836 cooperative fire insurance companies were formed in New York State, but concerning these early organizations very little information is now available. In succeeding years, however, many such organizations have been formed. In 1925 there were 165 cooperative fire insurance companies operating in the State, carrying $839,767,407 of risk.

The early cooperative insurance companies were followed a few years later by cooperative cheese factories and creameries, by agricultural societies and by purchasing organizations. These, in turn, have been supplemented by still other organizations in almost every field of agricultural business. The number of associations formed and years of organization or incorporation are given in Table 1.

Table 1.—*Associations grouped by years of incorporation.***

Period of incorporation	Associations reporting Number	Per cent
1850 – 1854†	3	.4
1855 – 1859	13	1.5
1860 – 1864	5	.6
1865 – 1869	11	1.3
1870 – 1874	6	.7
1875 – 1879	13	1.5
1880 – 1884	16	1.9
1885 – 1889	15	1.7
1890 – 1894	26	3.0
1895 – 1899	38	4.4
1900 – 1904	65	7.5
1905 – 1909	66	7.7
1910 – 1914	57	6.6
1915 – 1919	169	19.6
1920 – 1924	358	41.6
Total	861	100.0

In the study, upon the findings of which this article is based, the historical development of the cooperative movement in New York State is

*The information upon which this article is based was obtained from a survey of existing cooperative associations in New York State, supplemented by a study of available records concerning the activities of associations no longer active. The investigation was conducted during the fall of 1925 and spring of 1926 under the auspices of the Department of Agricultural Economics and Farm Management, Cornell University. The full report was submitted as a doctor's thesis in Agricultural Economics.

**For unincorporated associations the year of organization was used.

†The first cooperative fire insurance companies in New York were chartered by special acts of the Legislature in 1836. The dates of incorporation and number of such organizations are not available.

dealt with in some detail. In this discussion, however, it is intended to present only some of the economic factors brought out, and some of the conclusions drawn from an analysis of operating statements, balance sheets and other data.

Membership.

The total membership in cooperative associations in New York was 112,067, in 1925. The total number of patrons of the same associations was 137,149. The average numbers of members and patrons of 246 local associations and 14 central associations, in 1925, are shown in Table 2.

TABLE 2.—*Members and patrons of cooperative associations in New York, by type of business,* 1925.

Type of business	Number of associations	Average membership	Average number of patrons
Car-door feed and supplies	17	72	63
Cheese bargaining associations	11	38	41
Cheese factories	18	35	34
Creameries	18	52	89
Farmers' telephone companies	12	31	38
Feed and supply stores	33	122	173
Fruit packing associations	27	39	48
Grape marketing associations	11	160	157
Honey producers' associations	9	24	12
Horse breeders' associations	5	16	16
Milk plants	22	160	154
Miscellaneous	17	75	71
Potato marketing associations	12	50	53
Other vegetable marketing associations	11	207	151
Wool marketing associations	23	47	46
Total or average of local associations	246	79	86
Total or average of central associations	14	6,614	9,796

Volume of Business.

The average volume of business handled by local cooperative associations of different kinds is shown in Table 3. Milk plants handled by far the largest volume, followed by vegetable marketing associations, grape marketing associations, and creamery organizations. The milk associations averaged more than $300,000 worth of business in 1924 and averages for each of the other three kinds of associations exceeded $100,000.

TABLE 3.—*Average volume of business done by local associations in 1924, by type of business.*

Type of business	Number of associations	Average volume of business
Car-door feed and supplies	16	$ 13,782
Cheese bargaining associations	8	32,657
Cheese factories	13	22,268
Creameries	12	120,186
Feed and supply stores	27	87,368
Fruit packing associations	17	78,999
Grape marketing associations	11	163,882
Milk plants	11	303,184
Other vegetable marketing associations	10	168,828
Potato marketing associations	11	29,665
Wool marketing associations	6	13,650
Total or average	142	$ 92,663

Financing the Associations.

Information concerning the capital necessary to establish associations of different kinds was obtained from 173 associations now operating. (Table 4). Thirty-nine associations not included in this table were operating without permanent capital. Most of the latter group handled wool, or feed and supplies on a car-door basis. For each type of association the average closely approximates the amount most frequently invested. Of this average investment, 66 per cent was obtained from members and 34 per cent was borrowed. Ninety-eight associations obtained all their capital from members, 49 obtained part from members and part by borrowing, while 26 were operating entirely on borrowed funds.

TABLE 4.—*Capital investment in local cooperative associations.*

Type of business	Number of associations	Average investment
Car-door feed and supplies	9	$1,323
Cheese bargaining associations	5	37
Cheese factories	16	3,804
Creameries	17	5,116
Farmers' telephone companies	11	418
Feed and supply stores	34	15,583
Fruit packing associations	29	8,017
Horse breeders' associations	5	3,180
Milk plants	20	27,608
Potato marketing associations	10	3,283
Other vegetable marketing associations	6	4,197
Wool marketing associations	11	63
Total or average	173	$8,980

Of these 173 associations, 86 were of the capital stock form of organization and 87 of the non-stock.* The capital stock associations obtained 76 per cent of their capital from the sale of stock to members. (Table 5). This represents a permanent fund. The non-stock associations, on the contrary, obtained only 53 per cent of their capital from members and this on a revolving fund plan in which certificates of indebtedness were used. In nearly all cases the certificates of indebtedness provided that the amount thereof was to be repaid in equal installments over a period of 5 years by deductions from returns due growers for the sale of produce or from profits realized on sales of supplies. Forty-seven per cent of the capital of non-stock associations was borrowed from banks or from individuals other than members. Much of this was represented by loans that were overdue and subject to payment upon demand.

* Associations without capital stock, referred to here as "non-stock" associations, are numerous in New York and many other States. Such associations finance on borrowed capital if capital is necessary. In many cases they borrow from members either by means of direct loans or by retaining a portion of the returns due members for produce handled. As security for such loans the associations usually issue "certificates of indebtedness." These carry a provision for retirement. In New York many associations agree to retire their certificates by annual payments of principal and interest over a period of years, usually five. Funds for such purposes are obtained by making further deductions from returns due members. Capital obtained from members in this way represents a revolving fund.

TABLE 5.—*Methods of obtaining capital used by local associations.*

Method of obtaining capital	Number of associations	Amount obtained	Per cent of total
86 Capital Stock Associations:			
Capital stock	81	$659,169	76.2
Membership fees	2	895	0.1
Loans from banks and others	29	205,450	23.7
Total capital		$865,514	100.0
87 Non-stock Associations:			
Membership fees	31	$ 14,529	2.1
Loans from members	33	348,458	50.6
Loans from banks and others	55	325,113	47.3
Total capital		$688,100	100.0

From an analysis of the balance sheets and a comparison of balance sheet ratios of 52 associations from which detailed information on assets and liabilities was obtained, it was found that the capital stock associations were in a better position financially than the non-stock group. (Tables 6 and 7.) In the case of the non-stock associations, 69 per cent of the liabilities were of the current type, that is, they were payable during the fiscal year. Only 29 per cent of the liabilities of the capital stock associations were current. The ratio of current assets to current liabilities, often referred to as the current ratio, was 1.56 to 1 for capital stock associations and .86 to 1 for non-stock associations. The number of associations with no current liabilities was much larger for stock associations than for non-stock. (Table 8.) This simply means that the capital stock associations had a dollar and a half of current assets to meet each dollar of current liabilities. The current ratio is important to bankers or persons from whom the association may wish credit. Other things being equal, the higher the current ratio, the better is the position of the association from the viewpoint of creditors.

The ultimate ability of any business to meet obligations depends upon the owner's equity in the business, often referred to as net worth. In the case of capital stock associations, 71 per cent of the liabilities shown on the balance sheet represented equities of members in the form of capital stock and reserves. The non-stock associations, on the contrary, showed a membership equity of only 10 per cent. The range of membership equities is shown in Table 9. In fairness to the non-stock associations it should be stated that a large part of their liabilities was owing to members on certificates of indebtedness. It may be argued that money borrowed on certificates should not be considered in the same class as liabilities to creditors other than members. This viewpoint is appreciated, but it is also true that except where a condition of issue makes the certificate holder a junior claimant, or where the certificate is repayable only after the death, withdrawal or expulsion of the member from the association, the banker or other creditor must consider the member who holds the association's certificate of indebtedness as a claimant with the same rights as other unsecured creditors.

The method of financing by the use of certificates of indebtedness (found in some sections of the United States) under which no repayments of such certificates are made until, and unless, the fund has reached a certain fixed amount is probably not open to quite the same criticism. In general, however, a non-stock association, even though it obtains as much of its capital

TABLE 6.—*A comparison of the assets of capital stock and non-stock local associations (only associations with permanent capital investments are included).*

Kind of asset	AVERAGE ASSETS PER ASSOCIATION			
	28 stock associations		24 non-stock associations	
	Amount	Per cent	Amount	Per cent
Current Assets:				
Cash	$ 2,052.07	10.2	$ 861.99	4.5
Accounts receivable	4,630.10	23.1	3,973.64	21.0
Notes receivable	141.13	.7	1,193.06	6.3
Inventories	1,953.57	9.8	4,018.38	21.2
Accrued income			11.06	.1
Deferred assets	31.28	.2	405.03	2.1
Other current assets, securities, Investments, etc.	244.46	1.2	287.59	1.5
Total current assets	$ 9,052.61	45.2	$10,750.75	56.7
Fixed Assets:				
Equipment and fixtures	$ 3,395.01	16.9	$ 1,996.52	10.5
Land and buildings	7,598.13	37.9	6,216.48	32.8
Total fixed assets	$10,993.14	54.8	$ 8,213.00	43.3
Total Assets	$20,045.75	100.0	$18,963.75	100.0

TABLE 7.—*A comparison of the liabilities of capital stock and non-stock local associations (only associations with permanent capital investments are included).*

Kind of liability	AVERAGE LIABILITIES PER ASSOCIATION			
	28 stock associations		24 non-stock associations	
	Amount	Per cent	Amount	Per cent
Current Liabilities:				
Notes payable	$4,022.20	20.0	$11,043.34	58.2
Accounts payable	1,624.01	8.1	291.86	1.5
Certificates of indebtedness maturing 1925 *			658.27	3.5
Accrued accounts	153.45	.8	146.86	.8
Other current liabilities	20.32	.1	988.36	5.2
Total current liabilities	$ 5,819.98	29.0	$13,128.69	69.2
Fixed Liabilities:				
Mortgage	$ 51.78	.3	$ 1,283.33	6.7
Certificates of indebtedness (excluding amount due in 1925)			2,633.08	13.9
Total fixed liabilities	$ 51.78	.3	$ 3,916.41	20.6
Net Worth:				
Capital stock	$ 7,397.80	36.9		
Reserves	898.75	4.5	541.69	2.9
Surplus	5.877.44	29.3	1,376.96	7.3
Total net worth	$14,173.99	70.7	$ 1,918.65	10.2
Total Liabilities and net worth	$20,045.75	100.0	$18,963.75	100.0

* The amount due or payable during the current year on certificates of indebtedness was estimated as equal to one-fifth of the total certificates outstanding. This is a conservative estimate. It does not include amounts due but unpaid from previous years, the exact sum of which could not be determined.

TABLE 8.—*Ratios of current assets to current liabilities of capital stock and non-stock local associations (only associations with permanent capital investments are included).*

Range of current ratios	28 capital stock associations	24 non-stock associations
	Number	Number
0.0:1 — 0.49:1	6	8
0.5:1 — 0.99:1	0	5
1.0:1 — 1.49:1	4	6
1.5:1 — 1.99:1	2	2
2.0:1 — 2.49:1	2	0
2.5:1 — 2.99:1	1	0
Over 3.0:1	2	1
No liabilities	11	2
Total	28	24
Average current ratio:		
Capital stock associations		1.56:1
Non-stock associations		0.82:1

TABLE 9.—*Ratios of net worth to total liabilities of capital stock and non-stock local associations (only associations with permanent capital investments are included).*

Per cent that net worth is of total liabilities	28 capital stock associations Number	24 nonstock associations Number
Less than 10	1	10
10 — 19.9	0	5
20 — 29.9	0	2
30 — 39.9	2	3
40 — 49.9	2	2
50 — 59.9	2	0
60 — 69.9	3	0
70 — 79.9	0	0
80 — 89.9	3	0
90 —100.0	15	2
Total	28	24
Average ratio of net worth to total liabilities:		
Capital stock associations		70.7
Non-stock associations		101.1

from members as the capital stock associations, but on a loan basis instead of by the sale of capital stock, is not so good a risk. In times of financial stress such an association is likely to encounter pressure from outside creditors sooner than the capital stock association.

Another very serious objection to the currently maturing type of certificate of indebtedness is that the association employing this method of financing must create, each year, a fund large enough to meet its maturing certificates. To do this the association must make a deduction per unit from the returns due growers for commodities marketed, or add to the cost of supplies purchased for members. If competition is keen it is often very hard to do this and retain patronage. The capital stock association with a permanent capital fund is not so likely to be embarrassed in this way and is in a better position to meet keen competition. For these reasons, it is believed that the capital stock plan of financing is best adapted to the use of local associations requiring substantial capital for fixed investment; but, if it is decided to use the non-stock method, then certificates of indebtedness that mature only after death, withdrawal or expulsion of the member or those maturing after a stated capital requirement has been met should be used. Capital so obtained represents a fairly permanent fund. It is

believed that this method of financing is preferable to methods which require that money loaned by members be repaid in current annual installments.

What has just been said, of course, applies to associations needing capital for land, buildings, equipment and inventories. There are, however, many associations which do not need large capital investments. For these associations, the non-stock method of financing is quite satisfactory. Again it should be stated that these conclusions are drawn from a study of local associations. Not enough information was obtained on large federated or centralized associations to warrant conclusions being drawn, but it is safe to say that poor financing was a contributing cause of the failure of several large non-stock associations in New York in recent years.

Management.

Information on managers' experience indicates that 83 per cent of the persons entrusted with the guidance of New York associations were raised on farms, and an additional 10 per cent had acquired farm experience in later life. Ninety per cent of the managers had been members of cooperative associations, about 21 per cent of the managers had an advantage of 15 years previous experience in business similar to that in which they were engaged for the association, and 63 per cent had an average of 13 years experience in some kind of business other than farming. The average age of association managers was found to be 49 years and about 60 per cent of them were between 40 and 60 years of age.

A comparison of the educational qualifications of association managers with the education of farmers indicates that the managers have an advantage. About 75 per cent of the latter have high school or college training, compared with approximately 30 per cent in the case of farmers. Table 10.

TABLE 10.—*Education of association managers compared with that of farmers.*

Education	Managers		Farmers*		Farmers**	
	Number	Per cent	Number	Per cent	Number	Per cent
Grammar school only	17	21.8	398	69.5	358	67.4
High school	43	55.1	165	28.8	141	26.6
College or university	16	20.5	10†	1.7	16	3.0
Other	2	2.6	—	—	16	3.0
Total	78	100.0	573	100.0	531	100.0

* Cornell Bulletin 295, p 252. Data obtained from a survey of Tompkins County, New York, 1908.
** A summary of data contained in Cornell Bulletins 421, 433, 438, 441, and 442. These publications are the result of economic studies of dairy farming in six different regions during the years 1922-1925, inclusive.
† Referred to as "more than high school."

Management Costs.

The relationship of management costs to overhead and volume of business is important. Many association managers, or secretaries acting in that capacity, do so at little or no expense to the association. In many cases, however, management costs are an important factor. Again many associations operate only seasonally; for example, fruit or vegetable marketing associations. Most New York cooperative associations are in competition with private dealers. Many of these dealers are engaged in several different types of business or handle a variety of commodities. This permits them to utilize their plant and equipment to better advantage, with resulting lower per unit cost. Some cooperatives have found it to their advantage to diversify their activities as their private competitors have done.

Membership Contracts.

The managers of associations were rather evenly divided in their opinions as to the value of contracts with members. Many expressed the view that a State or regional association could enforce contracts better than a local, because of the fact that in the case of a local association the personal element entered too prominently into the relations of managers with members. All managers were agreed that service was of more importance than contracts in holding a loyal membership.

Fewer Associations Near Large Cities.

There are today fewer cooperative marketing associations in counties near large cities than in those more remote. This is true even where the agricultural output of counties near large cities is as large as in the more distant counties. The probable explanation of this is that there is less need for cooperative marketing near large urban centres where competition is keen and prices received by producers more nearly approach those paid by consumers than the prices received by distant producers. The rapid growth of up-State cities in recent years has improved the local markets for many farmers. The extension of State roads and the use of trucks has brought regions 50 miles distant within comparatively easy reach of the large cities. Indeed, dealers' trucks from cities 100 miles distant are present daily in the fruit and vegetable producing areas of New York during the crop-moving season. Producers should consider these factors before organizing new associations.

Less Competition Where Large Investment is Needed.

The handling of some commodities requires a large amount of capital, much of which must be invested in plant and equipment. Milk and canning factory products are in this class. Thus, there is likely to be less competition in the handling of these products than is found where only a small investment is necessary to operate. In such cases a bargaining association of the non-stock type may be useful for the purpose of negotiating with the purchaser. It is well to consider carefully the kind of commodity to be handled and the method of marketing, when discussing the formation of new associations.

Application of Business Principles.

A cooperative association is a business organization dependent for its success upon the adoption of sound business practices. In some cases cooperatives have materially improved business methods. In the case of cooperative associations, success is likely to be measured in dollars and cents just as it is in private business. Loyalty and good will are valuable assets to which a cooperative association may fall heir, but these must be retained by giving service comparable to that provided by competitors. The adoption of methods that lead to sound business practices is absolutely necessary to the success of a cooperative enterprise. One of the foundations of good business is adequate accounting. Members should be informed annually or more often concerning the financial status of their association. The books of an association should be audited annually in all cases, and, where the size of business justifies, semi-annual or quarterly audits should be made. Many associations have failed because of the fact that no records

were kept and no check-up made until it was too late. Eighteen per cent of the associations studied had never had their books audited (Table 11,) and in the case of 32 per cent of the associations it was uncertain whether or not an audit had ever been made. Thirty-nine per cent reported annual audits and 11 per cent reported that audits were made more frequently than that, several stating that monthly audits were made. In fairness it should be said that many of the associations that were lax in their accounting or

TABLE 11.—*Frequency of audits in local cooperative associations.*

Frequency	Number of associations	Per cent
Weekly	1	0.5
Semi-monthly	1	0.5
Monthly	7	3.3
Quarterly	10	4.7
Semi-annually	4	1.9
Annually	83	39.3
Uncertain	67	31.8
Never audited	38	18.0
Total	211	100.0

auditing practices did a very small business and no serious financial loss would have been incurred by their failure. Unfortunately, however, this is not always the situation. It should also be stated that many cooperatives, particularly the larger associations, have kept excellent records and know at all times just where they stand.

Effects of Professional Promotion.

Professional organizers have, at times, been active in promoting co-operative associations. For some years organizers went about the State forming cheese factory and creamery associations and erecting and equipping the plants for farmers. These activities have cost farmers many thousands of dollars. An attempt was made in this investigation to determine the cost to farmers of such activities, and the degree of success attending associations so organized. For that purpose, a comparison of the data obtained from 17 cheese factories and creamery associations organized by promoters with similar data obtained from 21 associations formed by farmers themselves was made. (Table 12). Promoted organizations operated only about half as long as those organized by farmers and cost about twice as much.

TABLE 12.—*Relation of method of organization to the losses sustained by members of cooperative cheese factories and creameries organized between* 1895 *and* 1913.

	Associations organized by farmers	Associations promoted by others
Number of associations	21	17
Average years of operation	9.7	5.3
Membership per association	39	34
Average initial investment	$2,223.33	$4,160.29
Investment per member	$ 57.01	$ 122.36
Assets per association at close of business	$1,355.95	$1,398.53
Liabilities per association at close of business	$2,510.47	$4,295.59
Loss per association at close of business	$1,154.52	$2,897.06
Average loss per member	$ 29.60	$ 85.20

Associations for the cooperative purchase of pure bred sires have been successful in many places and are a very desirable type of cooperative activity. Where organized by professional promoters, however, they have too often proved a costly experiment. Information concerning the cost of operating 5 horse breeders' associations in New York in 1925, was obtained in this study and reported by Prof. V. B. Hart in the American Agriculturist, June 12, 1926. These associations had been organized by "high pressure" salesmen the year previous. The average cost of the sires placed with these associations was $3,180, and the investment per member was $194. On the year's operations the average cost per colt obtained or expected was estimated at $161. The amount paid for these sires was greatly in excess of their real value and the ventures proved rather expensive to those who subscribed stock.

Reasons for Ceasing Operations.

Reasons for ceasing to operate in the cases of 242 associations that were inactive in 1925 are shown in Table 13. It should be stated that in many instances the reasons given are broad and in general terms only. There are usually many contributory reasons and very often the real cause may have been overlooked. For instance, "insufficient business" as the final cause of ceasing to operate, may be the result of any one or more contributing factors.

TABLE 13.—*Reasons for ceasing to operate, (242 inactive associations).*

Reasons	Associations reporting: Number	Associations reporting: Per cent
Insufficient business	78	21.5
No further need	76	20.9
Lack of interest	67	18.5
Replaced by another cooperative	21	5.8
Inefficient management	19	5.2
Failure of central association	16	4.5
Dishonest practices	15	4.1
Insufficient capital	10	2.8
Falling prices	9	2.5
Control acquired by too few members	6	1.6
Too many varieties or poor quality produce	6	1.6
Other reasons	40	11.0
Total	363*	100.0

* Some associations gave more than one reason for suspension of activities.

The term "failure" is often applied to a cooperative association that has ceased operations, but not all of these associations were "failures" in the usual sense. Many, as in the case of cheese factories and creameries, served their purpose very successfully but were no longer needed under changed production and marketing conditions. A number of associations were replaced by other cooperative organizations, and should not be regarded as having failed.

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A CASE OF NATURAL CROSSING IN SWEET PEAS

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During the summer of 1924 studies of the duplex character in sweet peas were begun on Vancouver Island. In a comparatively new variety, Kenneth, which is classed officially by the National Sweet Pea Society as a rose pink, a great number of duplex blooms were found. Several of these were tagged and the seeds saved separately. These were planted at the Dominion Experimental Station, Summerland, in 1925, and amongst the progeny was discovered a plant with purple blooms.

Prominent members of the National Sweet Pea Society had early recognized the importance of a knowledge of genetic characters in sweet peas as an aid in sweet pea breeding and after extensive trials at the Burbage Experimental Station, Major Hurst published in the *Sweet Pea Annual* for 1913 (National Sweet Pea Society) the order of dominance of colour in sweet peas. Cream is the lowest recessive colour known, white is dominant to cream, tinged white to white, pink to tinged white, crimson to pink, and maroon to crimson, while the wild purple bicolour is dominant to all colours. Orange and salmon shades are dominant to white and cream but recessive to pink and crimson. All the purple and blue shades are dominant to the red shades from which the blue factor is absent. Purple maroon is dominant to maroon, maroon to mauve and lavender, and lavender to deep and pale blue. Seedsmen in Great Britain make practical use of this knowledge to test seeds grown for them under contract. As the sweet pea is normally self-fertilized, the presence of a dominant rogue in a trial plot indicates mechanical mixing or carelessness on the part of a grower, and careless growers are not wanted in a high class contract trade.

The presence of a purple dominant rogue in the progeny of tagged pods of a much lower recessive colour suggested that crossing had taken place. The seed of this purple rogue was therefore saved for testing and the results of two years are shown in the accompanying table.

The fact that the progeny of a purple rogue in a rose pink variety segregated into strains of both purple and pink in the F_2 and again in the F_3 generation proves that a cross had taken place and that some natural crossing may be expected in the fields of sweet peas being grown for seed in British Columbia. The importance of this fact will be recognized when it is stated that over 90 acres are devoted to growing sweet peas in British Columbia for the British market, and that one grower alone sold over $20,000 worth of sweet pea seed in 1926.

As cream is the lowest recessive colour, if any crossing takes place in a cream variety the effect would show up in the first generation. Several tests were made by growing cream varieties in close proximity to more dominant colours and planting out all the seeds from the creams. So far only negative results have been obtained.

In the present case the F_2 generation, instead of giving a simple Mendelian 3:1 ratio of purple to pink, produced a number of intermediates which again segregated in the F_3 generation. This was a chance cross,

1925 F_1 Generation	1926 F_2 Generation	1927 F_3 Generation
Deep purple	Very light purple	1 Blue 4 Purple
	Pale lavender	13 Pale lavender 6 Tinged white 1 Blue
	Deep lavender	15 Dark lavender 7 Pale lavender 8 Tinged white
	Light purple	35 Light purple 5 Deep purple 10 Pink
	Deep purple	7 Light purple 1 Dark purple 5 Lavender 6 Pink 2 Tinged white
	Deep rose pink	4 Pink

the purple parent plant being unknown. It is evident, however, that this purple parent was heterozygous, containing a strain of lavender which is recessive to purple but dominant to pink. This is further borne out by the fact that in all the lavender plants in both the F_2 and F_3 generations the base of the standard bore delicate pencilling streaks of brown. This pencilling did not appear in either the purple or pinks. The number of plants tested was too small to determine Mendelian ratios. Nevertheless the tendency to segregate into dominant and recessive colours was plainly indicated. In each case the segregations agreed with the order of dominance published by Major Hurst.

Summary

1. A dominant purple rogue found in the progeny of a tagged pod of a pink variety of sweet peas suggested that a natural crossing had taken place.
2. The order of dominance of colour in sweet peas already published was applied to check up on the progeny of this rogue.
3. The factors segregated in the F_2 and F_3 generations along Mendelian lines, indicated that a cross had taken place.
4. Intermediates appeared indicating a heterozygous parent in the original cross.
5. The sweet pea is normally self-fertilized.
6. The presence of dominant rogues is made use of by seedsmen to check up on growers under contract.
7. The possibility of natural crossing in sweet peas is of interest to commercial seed growers as this is an important growing industry.

Dominion Experimental Station,
Summerland, B.C.

NOTES.

WESTERN CANADIAN SOCIETY OF AGRONOMY.

Report of Eighth Annual Meeting.

The Western Canadian Society of Agronomy met for its eighth annual meeting in the Board Room at the Manitoba Agricultural College on December 28th, 1927. The meeting was called to order by Dr. L. E. Kirk.

The minutes of the previous meeting were read and approved, and correspondence from the Deans of Agriculture of the Universities of Manitoba, Saskatchewan and Alberta and the Deputy Ministers of Agriculture of the Prairie Provinces and the Dominion of Canada was read in reply to resolutions forwarded to them from the last meeting.

Dr. L. E. Kirk delivered the Presidential address.

The Secretary-Treasurer's report was given by Professor J. H. Ellis, who drew attention to the fact that the President and Secretary-Treasurer had been appointed at the last meeting while they were on leave of absence and out of the country. They were unable to assume active work in the Society until July and the Secretary strongly urged that this was a procedure that was neither in the best interests of the Society nor fair to such elected officers. He suggested that in future no one be elected to office who was unable to assume active work in the Society.

The following special committees were appointed:

(a) *Resolutions Committee.* H. G. L. Strange, J. D. Matthews, M. J. Tinline.

(b) *Nominations Committee:* A. W. Henry, V. Matthews, J. H. Ellis.

CROP AND SEED TECHNOLOGY SESSION.

Chairman—J. E. Blakeman.

The first afternoon was devoted to a Crop and Seed Technology Session and the following papers were presented:—

1. Some of the problems in the production of elite stock seed and registered seed from an agronomic viewpoint, by H. G. L. Strange, Fenn, Alberta, President, Canadian Seed Growers' Association.
2. Seed plot and field inspection problems, by G. M. Stewart, Dominion Seed Branch, Calgary.
3. Production of elite stock seed, by W. T. G. Wiener, Cerealist, Manitoba Agricultural College.
4. (a) Seed drill surveys in Manitoba, by N. Young, Dominion Seed Branch, Winnipeg.
   (b) Seed drill surveys in Saskatchewan, by M. P. Tullis, Field Crops Commissioner, Regina, Sask. (read by N. Young).
   (c) Seed drill surveys in Alberta, by G. M. Stewart, Dominion Seed Branch, Calgary.
5. Identification of Agropyron species and the origin of commercial grass seeds and their characteristics, by F. E. Foulds, Dominion Seed Branch, Winnipeg.

Plant Breeding and Genetics Session.

Chairman—G. M. Stewart.

This session was arranged by the Plant Breeding anr Genetics Committee, and the following papers were presented:—

1. A dwarfing character in sweet clover, by A. T. Elders, Dominion Experimental Farm, Brandon.
2. Potentialities of sweet clover as plant breeding material, by Dr. L. E. Kirk, University of Saskatchewan.
3. Natural crossing in flax, by Dr. A. W. Henry, University of Alberta.

Plant Pathology Session.

A session was planned as a Plant Pathology Session at which two papers were to be presented. Owing to the short time available only one of these papers was given at the Thursday morning session. This paper dealt with:

Physiological forms of black stem rust appearing in Western Canada in 1927, by Dr. M. Newton and T. Johnson, Dominion Rust Research Laboratory, Manitoba Agricultural College.

On the morning of December 30th, the remaining paper, postponed from January 29th, was presented. This paper dealt with:

Sulphur dusting for rust control, by Dr. D. L. Bailey and F. J. Greaney, Dominion Rust Research Laboratory, Manitoba Agricultural College.

Canadian Co-operative Wheat Producers Limited Luncheon.

The members of the Society were the guests of the Canadian Co-operative Wheat Producers Limited at a luncheon given at the Fort Garry Hotel, on Thursday, December 29th. Forty members were present. At the luncheon a paper was read by D. R. McIntyre, Eastern Selling Agent of the Wheat Pool, on "The movement of Canadian wheat." This excellent paper was well received and provoked considerable discussion. A vote of thanks was tendered to the Canadian Co-operative Wheat Producers Limited for the splendid luncheon and to Mr. D. R. McIntyre for his instructive paper.

Visit to Dominion Grain Research Laboratory.

The members inspected the Dominion Grain Research Laboratory at the Grain Exchange on the afternoon of December 29th, and were shown the equipment and work of the Laboratory by Dr. Birchard and Mr. Aitken.

The party then returned to the College and inspected the College Milling and Baking Laboratory under the direction of Professor W. F. Geddes, the Soils Laboratories under the direction of Professor J. H. Ellis, and the Dominion Rust Research Laboratory under the direction of Dr. D. L. Bailey.

Annual Banquet.

The members of the Society were entertained at a banquet in the Faculty dining room, Manitoba Agricultural College, on the evening of December 29th, at which the members were the guests of the Provincial Department of Agriculture. Deputy Minister J. H. Evans was Toastmaster and short speeches were given by President J. A. McLean, University of Manitoba, Dean W. C. McKillican, Manitoba Agricultural College, Dr. L. E. Kirk, University of Saskatchewan, President of the Society, Mr. W. R. Leslie, Superintendent, Dominion Experimental Station, Morden and Mr. H. G. L. Strange, Fenn, Alberta, President, Canadian Seed Growers' Association.

Field Experimentation and Soils Investigation Session.

Chairman—Professor T. J. Harrison.

The following papers were presented:

Soil moisture studies under dry farming conditions, by S. Barnes, Dominion Experimental Station, Swift Current, Sask.

Determining the cost of production of farm crops, by M. J. Tinline, Dominion Experimental Farm, Brandon, Man.

The Soils Investigation Committee report was made by Mr. S. Barnes, who reported that work had been commenced by members of the Committee in Manitoba, Saskatchewan and Alberta in the making of an inventory of the soils of the Prairie Provinces.

The Field Experimentation Committee submitted a report in three parts, dealing with the co-operative field experiments under way in Manitoba and Saskatchewan:

(a) The Manitoba section report was presented by W. T. G. Wiener.

(b) The Saskatchewan section report, prepared by Manley Champlin, who presented a synopsis of the work of the Saskatchewan Field Husbandry Association, was read by M. J. Tinline, Chairman of the Committee on Field Experimentation.

(c) E. C. Sackville gave a brief report of the work being done by the Illustration Stations in Saskatchewan.

There was no report from the Instruction and Extension Committee or from the Plant Breeding and Genetics Committee.

Nominations.

The report of the Nominating Committee was presented by Dr. A. W. Henry, as follows:—

Honorary Presidents: President H. M. Tory, University of Alberta,
President W. C. Murray, University of Saskatchewan.
President J. A. McLean, University of Manitoba.

Honorary Vice Presidents:
Dean W. C. McKillican, Manitoba Agricultural College,
Dean W. J. Rutherford, University of Saskatchewan,
Dean E. A. Howes, University of Alberta.

General Executive:
President—G. M. Stewart.
Vice President—M. J. Tinline.
Secretary-Treasurer—J. B. Harrington.
Curator—J. D. Newton.
Executive—A. H. Joel and T. J. Harrison.

On the motion of Dr. A. W. Henry, seconded by V. Matthews, these men were declared duly elected.

STANDING COMMITTEES.

On the motion of Dr. A. W. Henry, seconded by M. J. Tinline, it was moved that the Standing Committees continue and that the personnel of these committees be the same for 1928. The personnel of these committees is listed below:

Instruction and Extension: Manley Champlin; T. J. Harrison.

Plant Experimentation: M. J. Tinline; Manley Champlin; James Murray.

Plant Breeding and Genetics: C. H. Goulden; J. B. Harrington; J. R. Fryer.

Soils Investigation: S. Barnes; F. A. Wyatt; A. H. Joel; J. H. Ellis.

Crop and Seed Technology: J. E. Blakeman; G. M. Stewart; F. E. Foulds.

Plant Pathology and Physiology: W. P. Fraser; D. L. Bailey; R. Newton.

Dr. L. E. Kirk then retired as President of the Society and G. M. Stewart, the President-elect, occupied the Chair.

DATE OF MEETING.

The question of holding meetings of the Western Canadian Society of Agronomy at the time of the annual meeting, and as a section, of the Canadian Society of Technical Agriculturists was discussed, and the difficulties in this connection were brought out. It was finally moved by Mr. F. E. Foulds, seconded by Dr. A. W. Henry; "That in years in which the Canadian Society of Technical Agriculturists meets in the Prairie Provinces the Western Canadian Society of Agronomy arrange for meeting together with, and at the same time as, the Canadian Society of Technical Agriculturists." On the motion of Mr. V. Matthews, seconded by Mr. M. J. Tinline, this resolution was tabled till the next meeting.

Dr. L. E. Kirk presented an invitation from President W. C. Murray to the Society to meet at the University of Saskatchewan for the next annual meeting and it was moved by Mr. A. T. Elders, seconded by Professor W. T. G. Wiener, that the invitation of President Murray be accepted to meet at the University of Saskatchewan for the 1928 annual meeting and that the meeting be held at the usual time, the dates to be determined by the Executive.

J. H. ELLIS.

BOOK REVIEW.

INTRODUCTORY CHEMISTRY by Neil E. Gordon—(World Book Company, Yonkers-on-Hudson, N.Y. and Chicago, 1927.)

"Introductory College Chemistry" by the same author and publisher, previously reviewed (Vol. VI, p. 431, August, 1926) has been rearranged, abridged and supplemented with questions and references to supplementary readings, to adapt it to the requirements of secondary schools. Naturally and appropriately, references to the Journal of Chemical Education (of which the author is Editor) are given prominence.

It is commended to the attention of the High School teacher and to that of the general reader who desires a concise, clear and modern view of the content of descriptive and theoretical chemistry.—J. F. S.

LA CULTURE DES CHOUX-DE-SIAM

Joseph Ferland

Quelques Résultats

Valeur Alimentaire

La culture des choux-de-Siam semble gagner une popularité de plus en plus grande chez les cultivateurs de la province de Québec. Et ce n'est pas sans raisons car elle contribue à résoudre avantageusement l'un des grands problèmes de l'agriculture: celui de l'alimentation convenable, abondante et économique du bétail en général, et des vaches laitières en particulier.

L'importance des aliments succulents pour la production du lait en hiver n'est pas à discuter. Toutes les autorités agricoles s'accordent à reconnaitre leur utilité; non pas tant en raison de leur valeur nutritive intrinsèque que pour leurs bons effets sur l'appareil digestif des animaux et la meilleure utilisation qu'ils permettent des autres aliments.

Dans une bonne partie de la province de Québec la température n'est pas assez chaude pour que la culture du blé d'Inde fourrager soit avantageuse, et nos cultivateurs ne sont pas organisés ni préparés pour faire de l'ensilage de trèfle ou de fourrage-vert. D'ailleurs, le seraient-ils que ce mode de conservation ne semble pas, pour le moment, présenter de garanties suffisantes pour être généralisé.

Les plantes-racines restent donc l'aliment succulent le plus avantageux à produire en dehors des régions où le blé d'Inde vient convenablement.

Quand il s'agit, cependant, de traduire en piastres la valeur alimentaire des choux-de-Siam pour le bétail, la question se complique et prête à beaucoup de discussion.

Pour tenter de résoudre ce problème nous devons, je crois, faire une comparaison avec d'autres aliments plus généralement utilisés, en nous basant sur les renseignements fournis par les spécialistes en alimentation.

Si nous consultons "Feeds & Feeding", de Henry & Morisson, nous trouvons à la page 10, (17 ième édition) sous le titre: *Roughages and Concentrates.*—"Roots are watery and bulky, and contain relatively little nutriment per pound, yet based on the composition of the dry substance they are more like concentrates than roughages as they are low in fibre. They are really watery, or diluted concentrates". Ainsi les racines ressemblent plus aux concentrés qu'aux gros fourrages parce qu'elles contiennent peu de matières fibreuses; elles sont en réalité des concentrés aqueux.

A la page 240 du même volume, nous lisons: "Roots should be regarded not as roughages but as watered concentrates high in available energy for the dry matter they contain. All are low in crude protein compared to their content of carbohydrates. The studies of Friis in Denmark and Wing and Savage at the New York (Cornell) Station show that for the dairy cow a pound of dry matter in roots has the same feeding value as a pound of dry matter in grain, such as corn, wheat or barley. Wing and Savage found that mangels could replace half the grain ordinarily fed in a ration of grain,

mixed hay and silage without reducing the yield of milk or butter and that with grain at $30.00 per ton, mangels were an economical substitute when they could be grown and stored for $4.00 per ton".

Encore une fois on affirme que les racines ne doivent pas être considérées comme des gros fourrages mais comme des concentrés dilués, et, pour les vaches laitières, une livre de matière sèche des racines a la même valeur alimentaire qu'une livre de matière sèche des grains. On a pu remplacer la moitié de la ration de grain par des racines sans diminuer la production de lait ou de beurre.

A la page 24 du bulletin No. 56 (Québec) "Culture des Racines Fourragères" on lit: La matière sèche contenue dans les racines est très digestible; elle a la même valeur que la matière sèche des grains.

Si nous examinons maintenant les tables d'analyse des aliments, nous voyons que le coefficient de digestibilité de la matière sèche des choux-de-Siam est tout près de 90% (86-87) comme pour les meilleurs grains, tandis que le coefficient de digestibilité de la matière sèche du foin de composition diverse, varie de 55 à 65%.

D'après l'enseignement de ces auteurs et suivant les expériences qu'ils rapportent il faut donc conclure que les choux-de-Siam doivent être considérés comme des concentrés aqueux pour l'alimentation des vaches laitières puisque la matière sèche qu'ils contiennent possède une digestibilité aussi élevée que celle des grains et que, de fait, on a pu remplacer la moitié de la ration de grain par des racines.

D'ailleurs ne convient-il pas de comparer les racines aux aliments qui ont un rôle identique dans la ration. Quand on veut établir un record de production laitière, par exemple, a-t-on déjà tenté de remplacer les racines par un surplus de foin? Pourquoi ne le ferait on pas si la matière sèche des racines et du foin avait une valeur alimentaire équivalente.

Si l'on veut calculer maintenant la valeur des choux-de-Siam à la tonne, il faut voir dans quelle proportion ils peuvent remplacer les grains dans la ration. D'après le prix de ces aliments on pourra trouver assez exactement le montant qui doit être attribué logiquement à ces plantes dans leur estimation comme aliment du bétail.

En référant encore aux mêmes auteurs, nous voyons dans "Feeds and Feeding", à la page 384: "Haecker of the Minnesota Station has found that 1 lb. of dry matter in mangels or rutabagas is substantially equal to 1 lb. of mixed grain, 11 lbs. of mangels or 9 lbs. of rutabagas having the same value as 1 lb. of grain". C'est-à-dire que une livre de matière sèche de betterave ou de choux-de-Siam équivaut à une livre de grain mélangé et que 11 lbs. de betteraves ou 9 lbs. de choux-de-Siam ont la même valeur qu'une livre de grain. En d'autres termes, une tonne de choux-de-Siam vaut 222 lbs. de grains mélangés.

Le professeur Boving de la Colombie Anglaise qui calcule la valeur des différentes récoltes de la ferme d'après un système d'unités alimentaires par comparaison au blé a trouvé qu'une tonne de choux-de-Siam fournissait 222 unités nutritives, c'est-à-dire qu'elle équivant encore à 222 lbs. de blé.

Au Collège Macdonald, le département de l'agronomie vend les choux-de-Siam au département de l'industrie animale de $4.00 à 5.00 la tonne, suivant le prix des autres aliments.

Si une tonne de choux-de-Siam a la même valeur nutritive que 222 lbs. de blé ou de grains mélangés, il faut donc la considérer comme valant de $5.00 à $6.00 pour l'alimentation du bétail puisque ces grains se vendent de 2¼ sous à 2¾ sous la livre dans le commerce.

Cette valeur, qui n'est pas du tout imaginaire, puisqu'elle est basée sur des expériences sérieuses, se trouve encore accentuée chez les cultivateurs par le fait que, généralement, la ration ordinaire de leurs animaux, composée en partie d'aliments grossiers, est complètement dépourvue d'autres succulents. Dans ce cas les racines ont non seulement pour effet de fournir une nourriture plus digestible mais aussi d'apporter la succulence qui ne pourrait venir d'ailleurs, contrairement à ce qui a lieu dans plusieurs expériences.

Si l'introduction des racines dans l'alimentation est avantageuse, il ne faut pourtant pas tout attendre de ces plantes. Pour en obtenir de bons résultats, il faut avant tout que la ration soit bien équilibrée, c'est-à-dire, qu'elle contienne une quantité suffisante de matières azotées pour satisfaire les besoins de l'animal. Ce serait une erreur que de vouloir tout espérer de le digestibilité et de la succulence des racines et de ne pas s'occuper de fournir une ration par ailleurs bien balancée. C'est pour éviter ce défaut qu'il faudrait introduire également dans la ration des vaches laitières surtout, des aliments riches en protéine, (foin de trèfle, fourrages d'A.P.V. tourteaux, etc.). Nous pourrons ensuite retirer des choux-de-Siam tous les bons effets que l'on peut attendre de leur succulence et de leur digestibilité.

Cout De Production

Le coût de production d'un arpent de choux-de-Siam peut varier assez considérablement suivant la qualité du terrain et le système de culture. Il est certain que l'entretien d'un champ cultivé à la main coûtera beaucoup plus cher que l'entretien fait avec des machines modernes, de même que des opérations culturales négligées occasionnent plus de travail et plus de dépenses qu'une culture bien suivie.

Dans le "Rapport de l'Agriculteur du Dominion 1925", nous voyons à la page 15 qu'à la Ferme Expérimentale d'Ottawa le coût de production des betteraves fourragères a été de $74.00 à l'âcre ou $62.00 à l'arpent.

D'après des calculs que j'ai controlés moi-même dans plusieurs champs en 1926 et 1927, j'ai trouvé que cette culture coûtait entre $45.00 et $60.00 à l'arpent chez les cultivateurs et que l'on pouvait considérer la somme de $50.00 comme étant un prix moyen assez juste. Ce chiffre correspond assez bien, je crois, aux montants généralement trouvés dans les différents calculs.

Rendement

Maintenant que nous connaissons la valeur comparative des choux-de-Siam, à la tonne, et le coût de production à l'arpent il nous reste à considérer si nos cultivateurs peuvent espérer obtenir un rendement suffisant pour que cette culture soit réellement profitable.

Au cours de l'été dernier, j'avais à organiser et à surveiller des concours de choux-de-Siam dans les comtés de Beauce, Mégantic, Richmond et Wolfe. Dans vingt paroisses, 212 cultivateurs ont entrepris la culture d'un arpent de ces plantes. Pour avoir une idée quelque peu précise du rendement moyen à l'arpent j'ai demandé à chaque concurrent de me dire consciencieusement les dimensions de son champ et le poids de sa récolte. Voici le résumé des chiffres qui m'ont été fournis:

Rendements moyens des Choux-de-Siam

Comtés	Nombre de champs rapportés	Etendue en arpents	Récolte en tonnes	Rendement en tonnes moyen
Beauce	36	29	600	20.7
Mégantic	21	19.25	523	27.
Richmond	8	9.38	228	24.3
Wolfe	28	27.56	608	22.0
4	93	85.19	1959	22.9

Comme on le voit, sur un total de 93 champs pris au hasard, la moyenne de rendement a été de 22.9 tonnes à l'arpent.

On dira peut-être que ce chiffre n'aurait pas été aussi élevé si tous les concurrents avaient répondu à ma demande. Il est possible que le rendement moyen eut pu être abaissé de 2 ou 3 tonnes si j'avais eu les résultats des 212 champs; cependant, je suis sûr qu'il n'aurait pas été inférieur à 18 tonnes, car, si quelques champs ont produit 14 ou 15 tonnes plusieurs ont donné de 25 à 30 tonnes.

Ces récoltes, on l'admettra, sont bien supérieures à la moyenne obtenue dans ie passé par les cultivateurs de la province (10 à 12 tonnes à l'arpent). Mais il ne faut pas oublier que cette culture qui demande des soins particuliers en est encore presqu'à ses débuts et qu'un grand nombre de cultivateurs qui l'entreprennent ne font pas une préparation convenable du sol ni un bon entretien des plantes—le rendement est, de ce fait, diminué considérablement.—Il ne faudrait donc pas se baser sur leurs chiffres pour prononcer un jugement définitif sur la moyenne de récolte possible dans le province.

En 1926, dans des concours semblables à ceux de 1927, le rendement moyen a été d'environ 18 tonnes dans 180 champs.

Ces bons résultats sont attribuables en partie à la méthode de culture et à l'emploi d'engrais appropriés (l'addition d'engrais chimiques à la fumure organique est souvent nécessaire). Une température convenable est une chose essentielle évidemment—le cultivateur a toujours besoin de la Providence—mais les bonnes récoltes ne sont pas l'effet du hasard et quel été n'a pas sa part de soleil?

Pour mieux nous rendre compte de la valeur économique de la culture des choux-de-Siam, établissons maintenant le bilan des résultats obtenus en 1927, ou ils ont été controlés d'une facon plus particulière:

Nombre de champs	Rendement moyen	Coût de production	Valeur à $5.00 la tonne.	Bénéfice net.
93	22.9 tonnes	$50.00	$114.50	$64.50

En considérant un rendement moyen de 18 tonnes, la valeur de la récolte serait de $90.00 au lieu de $114.50 et le bénéfice net serait de $40.00 à l'arpent.

Comme le dit le professeur Godbout, de Ste. Anne de la Pocatière, il est avantageux de donner une vingtaine de lbs. de racines par jour et par vache ce qui représenterait un minimum de 2 tonnes pas tête pour la période ordinaire de stabulation.

M. L. C. Raymond, du Collège McDonald, déclare également dans la circulaire No. 58 qu'en raison de l'importance des racines pour l'alimentation du bétail, nous devrions au moins en cultiver une petite étendue sur chacune de nos fermes.

M. S. A. Hilton de la Ferme Expérimentale fédérale de Nappan, N.F., après avoir fait une comparaison de l'ensilage et des navets en vient à cette conclusion: "Tant que nous n'aurons pas de preuves du contraire nous recommandons les navets comme aliment succulent pour la production du lait en hiver.

Nous pouvons donc affirmer, avec ces autorités, qu'il est avantageux pour un cultivateur de Québec d'avoir chaque année, en plus des autres cultures nécessaires, un arpent ou deux de plantes-racines pour fournir la partie succulente de la ration d'hiver de son bétail laitier.

ACTIVITES DES SECTIONS

La vitalité croissante de la C.S.T.A. vient de se manifester une fois de plus par la création d'une section française nouvelle, couvrant le vaste territoire du nord-ouest de Québec et le nord de l'Ontario. Nous sommes heureux de faire suivre ici le compte-rendu de la séance d'inauguration de la jeune section qui fait honneur à l'esprit d'initiative et de coopération des techniciens agricoles qui exercent leurs activités dans la grande région de colonisation, si pleine de promesses, de la zône d'argile septentrionale.

FORMATION D'UNE NOUVELLE SECTION DE LA C.S.T.A.

Le 2 décembre 1927, les techniciens agricoles du nord de Québec et d'Ontario se réunissaient à Macamic (Abitibi) dans le but de procéder à l'institution d'une nouvelle section de la C.S.T.A. Le promoteur de cette fondation a été Monsieur J.-Harry Tremblay, inspecteur des Stations d'illustration attaché à la station expérimentale de Kapuskasing, secondé dans la partie québecoise par Monsieur Alex.-J. Rioux, agronome du district agricole d'Abitibi ouest.

Cette réunion des techniciens agricoles coincidait avec la troisième exposition avicole du comté d'Abitibi et une réunion des directeurs de la Société d'Agriculture. Les fêtes durèrent trois jours et remportèrent grand succès.

Un magnifique banquet servi à l'Hôtel Makamik, au cours duquel des discours très intéressants furent prononcés, marqua leur début.

Le 3 décembre, à 10 heures du matin, les agronomes se réunirent à la salle des Chevaliers de Colomb de Macamic. Etaient présents : MM. J.-Harry Tremblay, inspecteur des stations fédérales d'illustration, résidant à Kapuskasing, Adhémar Belzile, assistant régisseur de la station expérimentale de Kapuskasing, F.-X. Gosselin, surveillant des parcelles de la station expérimentale de Kapuskasing, Rev. Père Stanislas Lajoie, O.M.I., missionnaire-colonisateur du Nouvel-Ontario, résidant à Kapuskasing, Louis-Jos. Bégin, agronome du comté de Témiscaming, résidant à Villemarie, Alex.-J. Rioux, agronome du district d'Abitibi-ouest résidant à Macamic, Armand Joubert, assistant-agronome du comté d'Abitibi, résidant à Macamic, Pascal Fortier, régisseur de la station expérimentale de La Ferme, Jos.-L. Albert, assistant-régisseur de la station expérimentale de La Ferme, Rosario Pelletier, surveillant des parcelles de la station expérimentale de La Ferme, Eugène Filiatrault, chef du service de l'aviculture de la station expérimentale de La Ferme, l'Abbé Charles Minette, missionnaire colonisateur de l'Abitibi, résidant à Amos et France Brien, agronome du district d'Abitibi-est, résidant à Amos.

Sur proposition de M. J.-Harry Tremblay appuyé à l'unanimité des assistants, Monsieur l'Abbé Chs. Minette est appelé à présider et, sur la proposition de M. Adhémar Belzile, aussi secondé à l'unanimité, Monsieur Alex.-J. Rioux est appelé pour enrégistrer les minutes de l'assemblée. Le prési-

dent invite Monsieur Harry Tremblay à prendre la parole. Ce dernier expliqua alors la procédure à suivre dans la formation d'une nouvelle section et prêcha aux membres la coopération dans les idées et dans le travail; il donna ensuite connaissance aux membres des correspondances qu'il avait échangées avec le secrétaire-général et avec les membres éligibles de cette section, de même que la liste des personnes qui pouvaient faire partie de cette nouvelle section, au nombre de trente.

Le président invite ensuite les membres à faire le choix de leurs officiers, soit par scrutin ouvert ou secret. Monsieur Adhémar Belzile propose alors que les nominations soient faites ouvertement et que le vote, s'il y a lieu, se fasse par main levée; cette proposition est secondée à l'unanimité et Monsieur Alex.-J. Rioux propose alors que Monsieur J.-Harry Tremblay soit élu président. Cette proposition est secondée unanimement par les applaudissements de tous les membres. Il est ensuite proposé par Monsieur Pascal Fortier et secondé par Monsieur Armand Joubert que Monsieur L.-H. Hanlan soit élu vice-président. Adopté unanimement. Monsieur Adhémar Belzile propose ensuite, secondé par Monsieur Jos.-L. Bégin, que Monsieur Alex.-J. Rioux soit élu secrétaire-trésorier. Adopté à l'unanimité. Aucune autre nomination n'étant faite, le président déclare élus MM. Tremblay, Hanlan et Rioux aux charges respectives de président, vice-président et secrétaire-trésorier.

On procède ensuite à l'élaboration de la liste des membres en règle et des membres éligibles. Les premiers sont au nombre de 16 et les autres sont au nombre de 14, donnant en perspective une section pouvant se composer de trente membres.

Le président demande ensuite la nomination d'un comité de législation devant être formé d'un président, d'un vice-président et d'un secrétaire, pour procéder à l'étude de la constitution et des règlements de la nouvelle section. Monsieur Adhémar Belzile, appuyé par Monsieur F.-X. Gosselin, propose que les membres du comité exécutif forment eux-même le comité de législation, occupant chacun leur charge respective, Adopté.

On commence ensuite, en comité général, l'étude de la constitution, mais un seul article est adopté définitivement, les autres devant être étudiés par le comité et soumis aux membres à la prochaine assemblée générale, en mars 1928. L'article adopté est le suivant:

NOM:—Les membres de la Société des Agronomes canadiens résidant dans le nord de Québec (Abitibi et Témiscaming) et le nord de l'Ontario (Cochrane, Hearst, Haileybury et Sturgeon Falls) abandonnent les sections auxquelles ils appartiennent pour former une nouvelle section connue sous le nom de "Section Québec et Ontario Septentrionale" (en français) ou Northern Québec and Ontario Branch (en anglais).

Le président lève alors la séance et annonce que les membres du comité exécutif devront convoquer les membres en assemblée générale au cours des trois premières semaines de mars 1928.

A. J. Rioux.

Grand Banquet de la Section de Quebec

Que dire du banquet organisé le 14 janvier dernier par la section de Québec, si ce n'est qu'il dépassa en éclat tout ce qui avait été fait jusqu'ici par une section de la Société des Agronomes canadiens. A sept heures et demi, plus de cent convives se pressaient autour des tables ornées de fleurs, de la grande salle de banquet du restaurant Kerhulu inondée de lumière. Etablissant un précédent qui ne manquera pas d'être invoqué à l'avenir, les toilettes claires d'un certain nombre de dames ajoutaient une note charmante, tempérant de la plus heureuse façon la sévérité du noir uniforme de l'habit masculin.

A la table d'honneur, monsieur Antonio Mathieu, président local de la section de Québec, avait à sa droite l'honorable J. Ed. Caron, ministre de l'agriculture de la province de Québec, en l'honneur duquel le banquet avait été organisé comme témoignage de sympathie à l'occasion de son élévation au rang de conseiller législatif. A sa gauche se trouvait Mgr. Camille Roy, Recteur honoraire de l'Université Laval de Québec, qui avait daigné prêter son concours à titre de conférencier principal de la soirée. On y remarquait encore messieurs Antonio Grenier, sous-ministre de l'agriculture, Ls-Ph. Roy, président général de la Société des techniciens agricoles du Canada; l'abbé Ulric Jean, délégué de l'Ecole d'agriculture de Ste. Anne de la Pocatière; H. M. Nagant, représentant de l'Institut Agricole d'Oka et de la section de Montréal de la C.S.T.A.; Antonio Ste-Marie, président de la section de Ste. Anne de la Pocatière; Georges Bouchard, membre du Parlement fédéral; Narcisse Savoie, chef du Service agronomique; Alphonse Désilets, chef du Service d'enseignement ménager; M. Jean-Chs. Magnan, agronome de Portneuf; Oscar Lessard, chef du Service de l'élevage; l'abbé H. Bois, inspecteur des Ecoles ménagères; J. B. Cloutier et plusieurs membres de l'Assemblée législative.

Un joli programme musical dont Monsieur Roméo Faguy, accompagné au piano par madame Maurice Talbot firent les frais, procura d'agréables intermèdes jusqu'au café, lorsque monsieur Antonio Mathieu se leva pour souhaiter le bienvenue à l'hôte d'honneur, l'Honorable ministre Caron, à Mgr. Camille Roy, le conférencier du banquet, aux délégués des collèges d'agriculture et des autres sections de la C.S.T.A. qui avaient voulu participer à la manifestation de ce soir, ainsi qu'aux notabilités du monde politique et administratif de la ville de Québec qui avaient bien voulu rehausser de leur présence cette fête agronomique.

Après cela, le président de la section locale profita de la présence de monsieur Louis-Ph. Roy, président général de la C.S.T.A., pour lui transmettre ses pouvoirs durant le restant de la soirée.

Pour l'édification des hôtes d'honneur et invités en dehors de la profession agronomique, monsieur Ls-Ph. Roy commença par faire un exposé aussi substantiel que précis de l'origine de la C.S.T.A. et du but que poursuit son activité dans le Dominion. Il fit notamment ressortir que la section du district de Québec ne représente qu'un des quatre groupements canadiens français de l'association, qui au total en possède actuellement 17, répartis sur tout le territoire du Canada, comptant un ensemble de plus de 1000 membres. M. Ph. Roy profita aussi de l'occasion, pour annoncer la grande con-

vention annuelle de la C.S.T.A., dont les assises à Québec, au mois de juin prochain, promettent d'être un des évènements sensationnels de la saison.

Il se fit ensuite l'interprête des hommages adressés par les techniciens agricoles à l'honorable ministre Caron et introduisit Mgr. Camille Roy comme conférencier. Celui-ci, en un langage d'une haute tenue littérature, fit ressortir les beautés de l'agriculture. Faisant d'abord un retour sur les classiques grecs et latins, il montra comment ils chantèrent la terre et sa beauté rustique en des oeuvres qui étaient à la fois des poèmes et un enseignement professionnel. Il rappela aussi quelques poètes canadiens qui célébrèrent la terre et les moeurs rurales et termina en affirmant l'intérêt que l'Université Laval porte aux études agronomiques.

L'Honorable ministre Caron remercia Mgr. Camille Roy et se dit fier d'avoir contribué à la création du corps agronomique dans la province de Québec, qui a déjà fait faire tant de progrès à l'agriculture, et dont l'enseignement est appelé à en faire réaliser bien davantage dans l'avenir. Le manque d'espace nous empêche de donner un compte-rendu du très intéressant discours de l'honorable M. Caron, lequel a d'ailleurs été publié in extenso dans les journaux locaux, dès le lendemain de la fête.

M. Georges Bouchard, député de Kamouraska au fédéral, se chargea de remercier Mgr. Camille Roy, qui fut son introducteur dans ses premiers essais littéraires, et le ministre Caron auquel il doit son initiation dans la carrière agronomique.

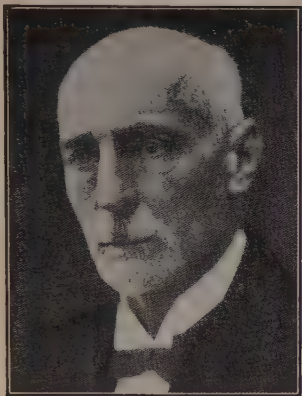
A onze heures, au milieu de l'enthousiasme général, cette belle séance dont le brillant succès est d'un présage vraiment encourageant pour la Convention générale du mois de juin, fut déclarée close.

H. M. N.

GRANDES FIGURES DE LA SCIENCE AGRICOLE DISPARUES AU COURS DE L'ANNEE 1927

L'année 1927 sera marquée par la perte de plusieurs sommités de la science agronomique. La première est Gustave André, membre de l'Académie des Sciences, professeur de Chimie agricole à l'Institut National agronomique de France, et Président du comité de rédaction des Annales de la Science agronomique, décédé le 11 mai 1927.

Tous les techniciens agricoles de langue française connaissent Gustave André par son *Traité de Chimie agricole,* divisé en deux parties dont la première est intitulée *"Chimie végétale"* et la seconde *"Chimie du sol"*, qui est un ouvrage classique dans le genre, où l'on voit que l'auteur s'est tenu constamment au courant des travaux et découvertes faites par les savants de tous les pays, dans le domaine de la chimie agricole.



Gustave Andre

Du dernier numéro des Annales de la Science agronomique, nous extrayons les notes suivantes, figurant dans l'article nécrologique consacré au savant disparu qui fait si grand honneur à la Science agronomique française. "Collaborateur de Berthelot pendant quinze ans, son nom est inséparable de celui de l'illustre chimiste lorsqu'il s'agit de rappeler les importantes recherches exécutées à Meudon sur la marche générale de la végétation, sur la répartition des nitrates et sur celles de l'acide oxalique dans un grand nombre de plantes. Les deux auteurs étudièrent longuement la composition des terres végétales, montrant que la matière azotée complexe des sols présente tous les caractères des amides. Puis, vinrent les recherches sur les constituants minéraux des terres, potassium, soufre, phosphore; des méthodes de dosage exactes furent élaborées permettant de définir les formes multiples que ces éléments affectent dans le sol.

Berthelot et André fournirent ainsi beaucoup de données de chimie générale sur les acides phosphoriques, sur la décomposition des sucres, sur les chaleurs de combustion des albuminoïdes et des principaux corps amidés qui en dérivent.

En 1897, G. André fut nommé professeur de chimie agricole à l'Institut National agronomique en remplacement de Th. Schloesing et durant trente ans il ne cessa d'étudier le sol et les plantes.

. Après avoir complété ses premières recherches effectuées avec Berthelot sur l'humus et examiné les conditions de sa transformation en ammoniaque, il aborda le problème de la solubilisation des éléments fertilisants contenus dans certaines roches. André a consacré plus de cinquante notes à l'évolution des matières minérales dans les végétaux, depuis la germination jusqu'à la maturation, déterminant leur répartition dans les différents organes, ainsi que leur partage entre les liquides de la plante et la partie insoluble. Un autre problème de physiologie végétale qui retint longuement l'attention de G. André, fut celui des excrétions minérales par les racines, qui fut étudié chez un grand nombre de plantes, en même temps que la forme sous laquelle les végétaux absorbent les composés azotés du sol. Comme si une telle production scientifique ne suffisait pas à satisfaire son ardeur au travail, André avait entrepris la rédaction d'un traité complet de chimie agricole, comprenant la chimie des plantes et la chimie du sol; et par la nous a rendu un service inappréciable.

Depuis 1902, la littérature agronomique française n'avait rien pour remplacer l'ouvrage de Déhérain, devenu d'ailleurs insuffisant. Aussi, la chimie agricole d'André connut-elle le plus grand succès. Trois éditions se sont succédé depuis 1909. Il faut avoir suivi de près l'édification d'un telle oeuvre pour se rendre compte de la somme de travail qu'elle représente, des recherches qu'elle a nécssitées, du nombre de mémoires qu'il a fallu consulter. Répandu dans le monde entier, le livre est par excellence celui auquel se reportent tous ceux qui s'intéressent au sol et à la végétation. L'académie

des Sciences lui décerna, en 1913, le prix Bigot de Marogues, réservé tous les dix ans à l'auteur de l'ouvrage qui aura fait faire le plus de progrès à l'agriculture de France. G. André laisse le souvenir d'un grand travailleur, d'un savant dévoué à la science et par dessus tout d'un homme de grand coeur.

Le professeur Constantin D. Glinka est une autre grande figure de la science agronomique, dont nous apprenons la décès survenu au cours du mois de décembre 1927. Président de l'Institut Agronomique de Pétrograd, il avait aussi été élu, au mois de juin dernier, lors du premier Congrès international de la Science du sol, tenu à Washington, à la présidence de l'Association internationale de la Science du sol. C'est au cours du Congrès de Washington et pendant l'excursion transcontinentale agro-géologique qui y fit suite que nous connumes la personnalité sympathique du Dr. Glinka, lequel, malgré ses 73 ans, jouissait encore d'une belle verdeur et avait supporté avec une étonnante résistance les fatigues d'une tournée de 31 jours consécutifs en pullman.

CONSTANTIN D. GLINKA

Pas autant connu peut-être que le professeur André dans la généralité des milieux agronomiques, le Dr. Glinka n'en était pas moins, depuis des années déjà, une figure dirigeante de la science agro-géologique.

Disciple d'un autre savant russe du nom de Dokutschajeff, il continua à développer le remarquable système de classification des sols qui adopte les conditions climatiques comme facteur principal et publia un célèbre ouvrage sur les "Grands groupes du sol du monde et leur mode de formation" qui vient d'être traduit en anglais par le Dr. C. F. Marbut, chief of the Soil Survey, Division, Bureau of Soils, U. S. Department of Agriculture. On sait que les principes du système russe de classification des sols ont non seulement été largement adoptés par la plupart des pays européens, tels que l'Allemagne, la Roumanie, la Pologne, la Scandinavie, la Hongrie, etc., mais encore par les Etats-Unis eux-mêmes, ainsi qu'ont pu le constater ceux qui prirent part à l'examen des nombreux profils de sols étudiés au cours de la grande randonnée du congrès international de la science du sol à travers les états de l'Union américaine et les provinces de l'ouest canadien, l'été dernier.

A cette occasion, les congressistes se plurent à admirer l'activité souriante du Dr. Glinka, toujours rendu un des premiers dans les profondes tranchées ou sur le versant des talus, où on l'appelait comme arbitre des discussions animées, que soulevait fréquemment la détermination du type exact de sol rencontré, dans une confusion de langues rappelant les travaux de la tour de Babel.

H. M. N.

WADE TOOLE.

Wade Toole, Professor of Animal Husbandry at the Ontario Agricultural College, died Thursday, January 12th, as the result of complications following an operation for appendicitis.

WADE TOOLE

The late Wade Toole was born at Whitevale, Ont., March 3, 1886. He received his B.S.A. degree from the University of Toronto in 1911, after which he joined the staff of the *Farmer's Advocate and Home Magazine* as Live Stock Editor. In 1913 he was promoted to Managing Editor, which position he filled with a great deal of credit to himself and to the paper, until the spring of 1918 when he was appointed Professor of Animal Husbandry at the Ontario Agricultural College. In 1923 he received his M.S. from the Iowa State College for post graduate work in animal breeding and research in meats. Under his able administration the Animal Husbandry Department of the O.A.C. has been very successful, and both experimental and teaching work have been greatly expanded.

Having a full appreciation of the wide field of work and the many problems facing animal husbandry men, he knew the need of co-ordination and co-operation in making orderly progress. To this end he was active in organizing the Eastern Canada Society of Animal Production and at the organization meeting of this Society, which was held in Toronto in November, 1926, he was unanimously chosen as President, which office he still held at the time of his death.

The late Professor Toole was honoured and respected by all who knew him for his energetic and fearless service in matters of live stock interest. With independence of thought and great sincerity he determined and followed that course which he felt to be right. For this independence and sincerity in character he earned the respect and devotion of all with whom he came in contact, than which there can be no greater tribute.

Scientific Agriculture and members of the C.S.T.A. join with the many friends of the deceased in extending to the widow and family sincerest sympathy in this time of sorrow and bereavement.—L. C. McO.

CONCERNING THE C.S.T.A.

THE T. EATON COMPANY SCHOLARSHIPS.

On the morning of January 18th last there appeared in a large number of daily newspapers a Canadian Press dispatch from Ottawa to the effect that a "large Toronto commercial house" had decided to award five scholarships of $600.00 each to university graduates who are members of the C. S. T. A., such scholarships to be tenable at any Canadian university offering post-graduate courses in agriculture and to be awarded by a committee of the C.S.T.A. at its next annual meeting, such committee to include one representative of the donors.

The "large commercial house" referred to in the dispatch is the T. Eaton Company Limited and the five scholarships will be awarded in 1928, 1929 and 1930, so that there are really fifteen scholarships to be awarded during the next three years.

The C.S.T.A. became actively interested in this project on November 17th last, when President J. B. Reynolds of the Ontario Agricultural College arranged for an interview with Mr. Robert Fee of the T. Eaton Company in Toronto, at which the General Secretary was asked to be present. At this meeting there was considerable discussion regarding the general principle of awarding scholarships in agriculture and the General Secretary was asked to make a written request at an early date so that it could be brought before a committee of the T. Eaton Company.

The second interview with the T. Eaton Company took place in Toronto on December 14th last. On this occasion the T. Eaton Company was represented by three members of its staff, under the chairmanship of Mr. Robert Fee, and the C.S.T.A. was represented by Dr. J. H. Grisdale, Deputy Minister of Agriculture for Canada, and the General Secretary. The main object of this meeting was to obtain from Dr. Grisdale an assurance that he, in his official position, found considerable difficulty in securing men with sufficient training to undertake the many important research projects requiring investigation and solution.

The third and final interview with the T. Eaton Company committee was held on January 10th at 10 a.m. and at this meeting the General Secretary was accompanied by Dean H. Barton of Macdonald College. By this time the T. Eaton Company had definitely decided to award a certain number of graduate scholarships and they asked Dean Barton and the General Secretary to prepare a written recommendation which would give the Directors of the T. Eaton Company the information necessary regarding the manner in which applications were to be received and the scholarships awarded.

The decision of the T. Eaton Company is given clearly in the following letter dated January 14th, 1928:—

"Mr. Fred. H. Grindley,
General Secretary, Canadian Society of Technical Agriculturists,
Canadian Society of Technical Agriculturists,
Box 625, Ottawa.
Dear Mr. Grindley,

We wish to inform you that the T. Eaton Company Limited is pleased to donate five scholarships of six hundred dollars each for three years in the interests of Canadian agriculture. These to be awarded by a committee of the C.S.T.A., as per your suggestion submitted.

Yours very truly,
(Signed) ROBERT FEE,
Assistant Superintendent."

Thus was brought to a conclusion a series of very pleasant meetings with the representatives of the T. Eaton Company Limited. It is extremely encouraging that this interest is being shown in Canadian agriculture by a strictly commercial house and it is also gratifying that they have decided to use the C.S.T.A. as a medium through which to award graduate scholarships.

Applications for the T. Eaton Company scholarships will be received up to June 1st, 1928, on regular application forms which can be obtained from the General Secretary. All applications will be placed in the hands of a committee at the Quebec convention in June, 1928, and the awards will be announced before the convention adjourns.

Notes and News.

Wade Toole (Toronto '11), Professor of Animal Husbandry at the Ontario Agricultural College for the past ten years, died suddenly at Guelph early on the morning of January 12th last. Elsewhere in this issue an account of his career is published. This was written by Mr. L. C.McOuat, Secretary of the recently organized Eastern Canada Society of Animal Production, of which the late Professor Wade Toole was the first President.

The Society lost another of its members through the death, during the latter part of November, of Mr. F. G. Gale (Dartmouth '76) of Waterville P. Q. He was one of the most prominent cattle breeders in the Province of Quebec.

H. R. Murray (Toronto '23) has returned to Cornell University for the winter. His address, until May 1, 1928, will be: Department of Vegetable Gardening, Cornell University, Ithaca, N.Y.

H. E. Miller (Toronto '26) is now with Ballantyne Dairies Limited, 313 Pitt Street East, Windsor, Ontario.

S. M. Denison (McGill '21) has been appointed a hog grader with the Dominion Live Stock Branch in Toronto. His address is: c/o West End Y.M.C.A., 931 College Street, Toronto, Ontario.

Roger P. Charbonneau (Syracuse '23) has changed his address to 4264 St. Hubert Street, Montreal, P.Q. He is Field Representative of the Quebec Holstein-Freisian Association.

P. M. Daly (McGill '21) is temporarily residing at his home in New Brunswick. His address is 263 Charlotte Street, St. John, N.B.

H. N. Racicot (McMaster '21), Plant Pathologist, Dominion Laboratory of Plant Pathology, Ste. Anne de la Pocatière, has been granted four months' leave of absence by the Dominion Department of Agriculture and is at the University of Toronto continuing his previous work of research in plant physiology. He will return to Ste. Anne de la Pocatière, P.Q. in February.

S. M. Walford (McGill '26) has been appointed inspector of R. O. P. work in the Poultry Department, Purdue University, La Fayette, Indiana, U.S.A.

J. E. McIntyre (Toronto '21) who has been Agricultural Representative in Bathurst, N.B., has had his office transferred to Chatham, N.B. His new address is Box 562, Chatham, N.B.

Dr. G. C. Creelman (Toronto '88) has changed his address for the winter months and is living at 404 Kenson Apartments, 51 Grosvenor Street, Toronto, Ontario.

E. G. Grest (Saskatchewan '26) is Assistant in Farm Management at the University of Saskatchewan.

Arthur Dumais (Laval '17) is now at Montmartre, Saskatchewan.

Alfred Savoie (Montreal '24) is with the Co-operative Fédérée de Quebec at 114 St. Paul Street East, Montreal.

Robert Raynauld (Montreal '25) has changed his address temporarily to 6696 Alma Street, Montreal.

D. G. Fidlar (Toronto '22) has been appointed a loan inspector with the Manufacturers Life Insurance Company at Regina. His address is 3048, 18th Avenue, Regina, Sask.

C. M. Slagg (Wisconsin '18) has resigned his position as Chief of the Tobacco Division, Dominion Department of Agriculture, which he has held for the past four years, and has accepted a similar appointment with the Australian Government. He left Ottawa on January 15th.

D. W. Thompson (British Columbia '26), formerly with the Dominion Seed Branch at Victoria, B. C., has been transferred to the head office at Ottawa, Ontario.

J. B. Smith (Toronto '23) is now with the Poultry Husbandry Department, Ontario Agricultural College, Guelph, Ont.

Antoine Goguen advises us that his address is now St. Louis, Kent County, N.B.

G. T. Jackson (Toronto '25), formerly Manager of the Saskatchewan Co-operative Creameries at Lloydminster has been transferred to Swift Current and is now acting as Manager at that point.

H. M. Tysdal (Saskatchewan '24) has been awarded an American-Scandinavian Foundation Fellowship, for the purpose of studying plant breeding and plant physiology and is now in Sweden. His address, until June, 1928, is Botany Division, Experimentalfaltet, Stockholm, Sweden.

W.J. Tawse (Toronto '15) who has been Lecturer in Horticulture and Apiculture at Macdonald College for the past ten years has accepted a position with the Niagara Brand Spray Company of Burlington, Ontario, as Sales Representative for Eastern Ontario and Quebec. He takes up his duties on February 1st.

I. F. Stothers (Toronto '23) advises us that his address is now Wilkie, Saskatchewan.

Among those who joined the Canadian National Railway Farmers' Marketing tour, and sailed from Halifax for Great Britain and Denmark on January 9th, were the following: H. S. Arkell, (Toronto '04), Dominion Live Stock Commissioner; George Batho, Editor of Publications, Manitoba Department of Agriculture; R. S. Duncan (Toronto '06), Direc-

tor of Agricultural Representatives, Toronto; F. C. Hart (Toronto '06), Director of Marketing, Ontario Department of Agriculture; A. P. MacVannel (Toronto '06), Agricultural Representative, Picton, Ontario; C. W. Buchanan (Toronto '11), Agricultural Representative, Port Arthur, Ontario.

L. C. Coleman (Toronto '04), who was granted two years' leave of absence by the Department of Agriculture in Mysore, India, and has been, during that time, Professor of Plant Pathology at Toronto University, has returned to India to again become Director of Agriculture in Mysore at Bangalore.

Local Branches.

Several meetings of the French members in Quebec have been held during the past two months. Complete reports of these are published in the French section of the journal and these should be read by all members of the Society who are familiar with the French language.

The Western Ontario local is holding weekly meetings during the winter months at the Board of Trade Chambers, Royal Bank Building, Toronto, every Friday.

The annual meeting of the Niagara Peninsula branch is to be held at the Village Inn, Grimsby, on Saturday, February 11th.

Dean E. A. Howes of the University of Alberta, addressed the members of the South Saskatchewan local on January 19th.

The Alberta local held a meeting in the Board of Trade Rooms in Calgary on January 18th. An address was given by Mr. Geo. McIvor on "The Movement of Canada's Wheat Crop."

The small local branch in North-western Ontario, with headquarters at Fort William, is holding regular monthly meetings at which one of the members, or some other available speaker, gives a short talk on some phase of agriculture of common interest.

Dominion Civil Service Vacancies.

The following positions are being advertised by the Civil Service Commission:—

Tobacco Specialist. Experimental Farms Branch for British Columbia. Initial salary $2,040 per annum, with increases at the rate of $120 per annum up to a maximum of $2,520. Applications close February 9th, 1928.

Animal Husbandman. (Bilingual). Experimental Farms Branch at Ottawa. Initial salary $2,040 per annum, with increases at the rate of $120 per annum up to a maximum of $2,520. Applications close February 16th, 1928.

Poultry Promoter (Temporary) (Male). Live Stock Branch in Alberta. Salary $1,620 per annum. In the event of the position becoming permanent the initial salary will be $1,620 per annum with increases, upon recommendation for efficient service, of $60 per annum up to a maximum of $1,920. Applications close February 11th, 1928.

Applications for Membership.

The following applications for regular membership have been received since December 1st, 1927:—

L. J. Begin, (Laval, 1920, B.S.A.), District Representative, Ville Marie, P.Q.

Adhemar Belzile, (Laval, 1913, B.S.A.), Kapuskasing, Ontario.

Jacob Biely, (British Columbia, 1926, B.S.A.), University of British Columbia, Vancouver, B.C.

C. E. Beveridge, (Saskatchewan, 1926, B.S.A.), Dairy Branch, Department of Agriculture, Regina, Sask.

J. Norman Bird, (Toronto, 1926, M.A.), Cornwall Collegiate Institute, Cornwall, Ontario.

W. C. Cameron, (British Columbia, 1925, B.S.A.), 610, 7th Ave. W., Calgary, Alta.

G. W. Challenger, (British Columbia, 1925, B.S.A.), 347 Victoria St., Kamloops, British Columbia.

P. A. Dorion, (Montreal, 1927, B.S.A.), Macdonald College, P.Q.

G. Gordon Dustan, (Toronto, 1927, B.S.A.), Entomological Laboratory, Horticultural Experiment Station, Vineland, Ontario.

Arthur Laing, (British Columbia, 1925, B.S.A.), 236 Smith Street, Vancouver, British Columbia.

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Life Members.

The first two members of the Society to take out Life Membership at $100, are Mr. B. L. Emslie, Canadian Delegate of the Chilean Nitrate Committee and Mr. F. H. Grindley, General Secretary of the C.S.T.A. These were received during the month of January.